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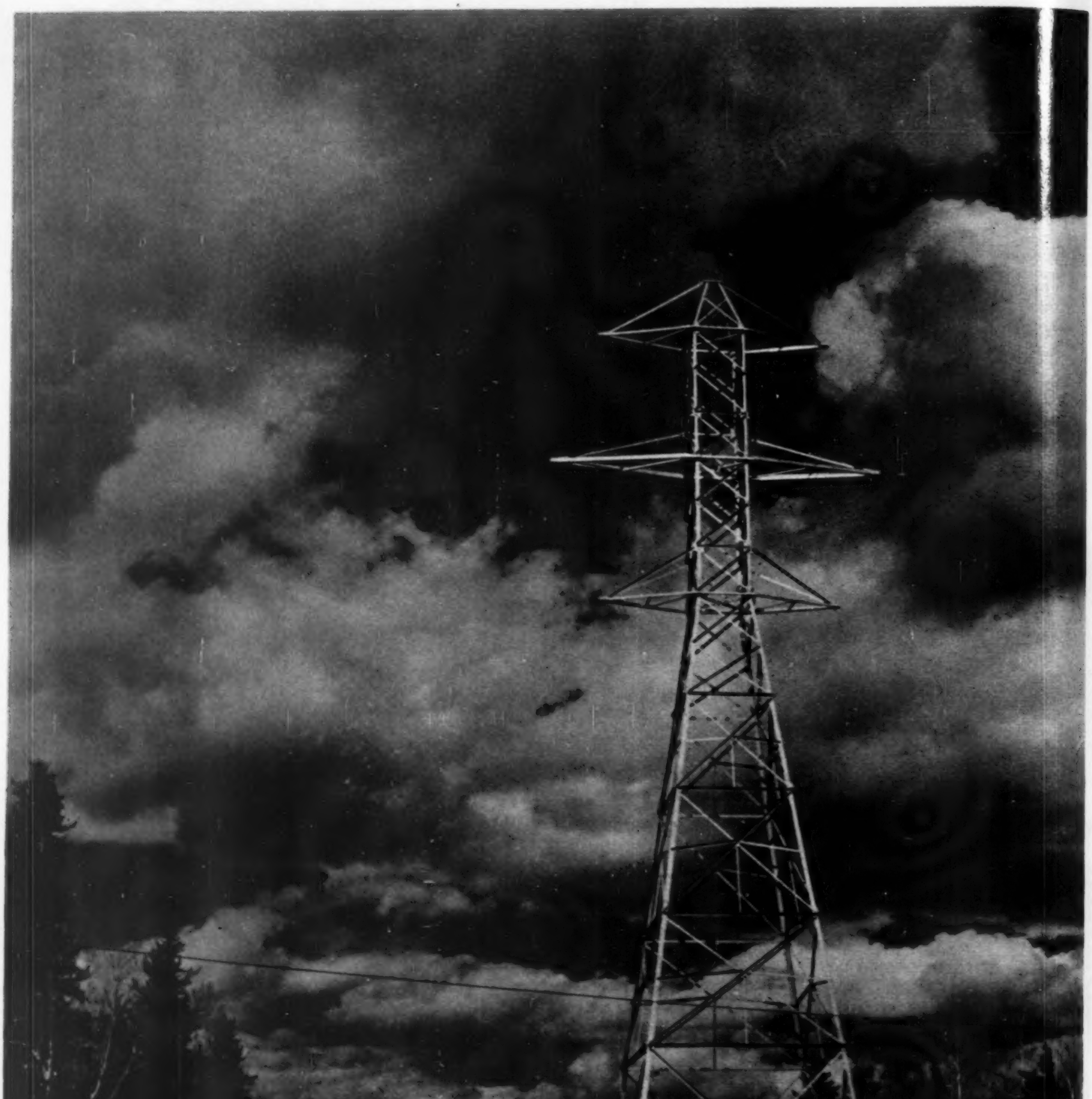

Steel towers start their long overland march to bring power from the new generating station at Kelsey in northern Manitoba to the nickel mining and smelting plant at Thompson, thirty-five miles away.

International Nickel Co. of Canada

✦

The Society's ambition is to make itself a real force in advancing geographical knowledge, and in disseminating information on the geography, resources and people of Canada. In short, its aim is to make Canada better known to Canadians and to the rest of the world.

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CANADIAN GEOGRAPHICAL JOURNAL

Editor - WILLIAM J. MEGILL

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The articles in this Journal are indexed in the *International Index to Periodicals* and in the *Canadian Index*.

The British standard of spelling is adopted substantially as used by the Government of Canada and taught in most Canadian schools, the precise authority being the Concise Oxford Dictionary, fourth edition, 1951.

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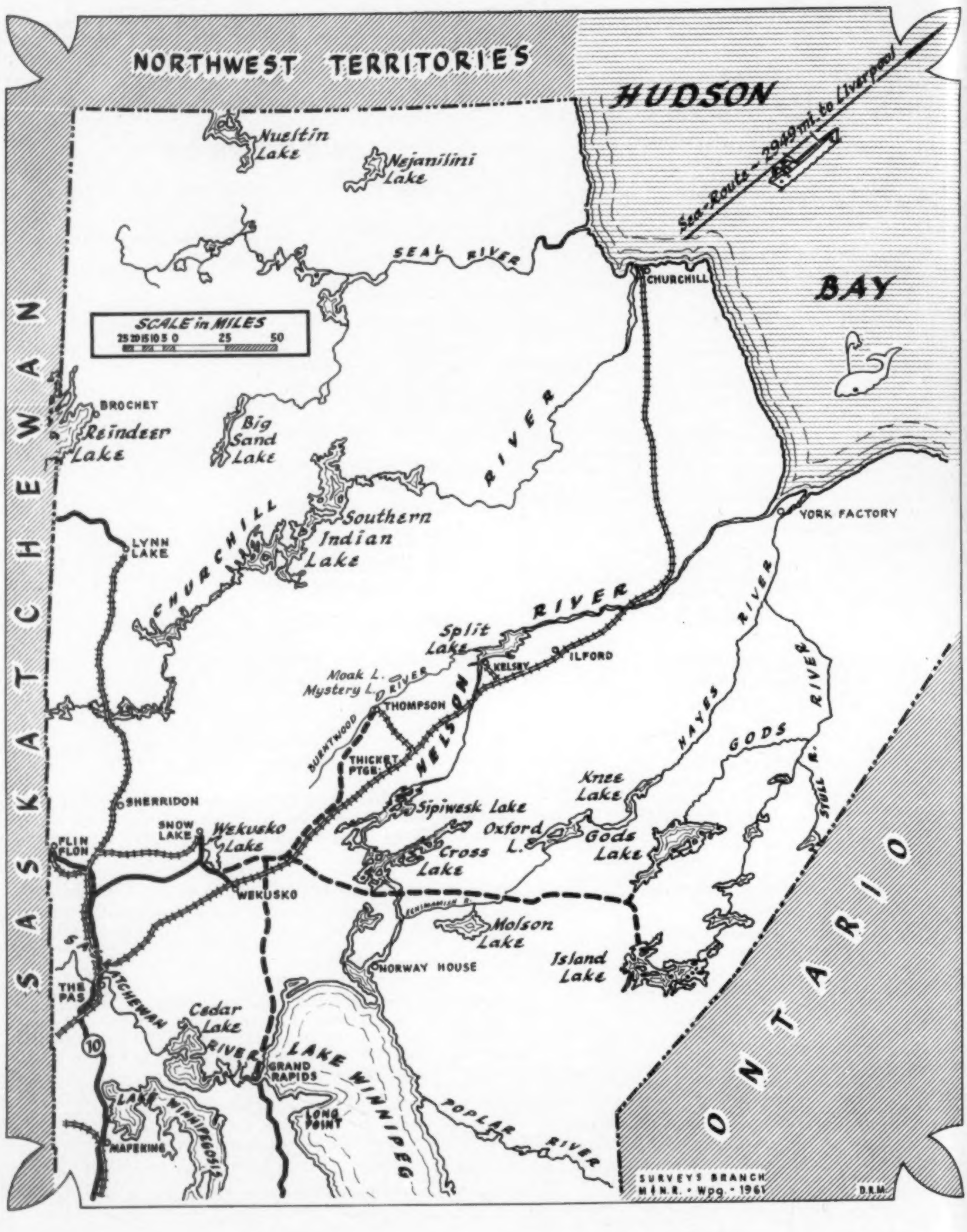


NORTHWEST TERRITORIES
HUDSON
BAY
Sea-Route – 2949 mi. to Liverpool
SASKATCHEWAN
ONTARIO
SCALE in MILES
25 20 15 10 5 0 25 50
Nueltin Lake
Nejanilini Lake
SEAL RIVER
CHURCHILL
BROCHET
Reindeer Lake
Big Sand Lake
CHURCHILL RIVER
Southern Indian Lake
YORK FACTORY
LYNN LAKE
NELSON RIVER
Split Lake
KELSEY
ILFORD
Moak L.
Mystery L.
BURNTWOOD RIVER
THOMPSON
THICKET PTGE.
HAYES RIVER
GODS RIVER
STULL R.
Knee Lake
SHERRIDON
Sipiwesk Lake
Oxford L.
Gods Lake
SNOW LAKE
Wekusko Lake
FLIN FLON
Cross Lake
WEKUSKO
ECHIMAMISH R.
Molson Lake
Island Lake
NORWAY HOUSE
THE PAS
SASKATCHEWAN RIVER
Cedar Lake
10
GRAND RAPIDS
LAKE WINNIPEG
LAKE WINNIPEGOSIS
LONG POINT
MAFEKING
POPLAR RIVER
SURVEYS BRANCH
M.N.R. · Wpg. · 1961
D.R.M.

A survey camp on Manitoba's northern boundary at 60° latitude.
Manitoba Dept. of Mines & Natural Resources

Manitoba's Northland Rediscovered

by C. B. GILL

Photographs by Manitoba Dept. of Industry and Commerce unless credited.

When Henry Hudson in the year 1610 entered the bay which was later named after him, although ostensibly looking for a short route to the spices of the Orient, he, like other early explorers, no doubt had hopes of finding gold or at least silver, as the Spaniards had already done far to the south. Had not his predecessor, Martin Frobisher, brought back to England from Frobisher Bay on Baffin Island fifteen shiploads of dark, heavy rock with glistening specks, which he and his partners in London believed to be gold ore, but which in the light of later knowledge was probably amphibolite with specks of mica?

Hudson could not dream that one day through a port on his bay would pour a stream of golden grain grown on the then unknown prairies of the interior. Nor could he know that a metal, then unrecognized, or if recognized, considered to be a nuisance in smelting and consequently named nickel (after the evil one) would one day be shipped to Europe through that port.

As it happened, the fur-trade was for long the source of the only wealth produced in the region now mapped as Manitoba, either north or south; and northern Manitoba had to wait until the twentieth century before any metal, precious or otherwise, was produced.

It was not until 1917 that the first metal was extracted from the stubborn rock of northern Manitoba, and this metal was primarily copper (the Mandy mine, near Flin Flon). About the same time, small quantities of gold came from the Wekusko (Herb Lake) region, but it was not until 1930 that large scale mining got underway with the opening of a mine by the Hudson Bay Mining and Smelting Company producing copper, zinc, gold, silver, platinum, and other metals.

We see from the above dates that there was a lapse of time of over 300 years between the

first search for precious metals in the Hudson Bay region and actual production. The reasons for this delay are not hard to find. Besides the overriding fact of inaccessibility and lack of adequate transportation, one has to consider the undeveloped state of mining and metallurgical methods at the time the country was first explored, and also the difficult nature of the ore-bodies.

The opening up of northern Manitoba by rail and highway in recent years will be discussed later in this article. With regard to knowledge of mining, Martin Frobisher's chronicler of his 1577 voyage to Baffin Land reported: "There is no manner of creeping beast hurtful, except some Spiders (which, as many affirme, are signes of great store of gold)." Why the valuable minerals were not found on the surface is explained by the geology of the area.

The surface rock of the region is for the most part of Precambrian age, being part of the so-called Canadian Shield, which forms a great arc or horseshoe around Hudson Bay, with its eastern lobe reaching north through Quebec, its western lobe stretching northwestward through the Northwest Territories, and having its opening to the north. The Precambrian rock consists largely of granites and gneisses, but includes also extensive belts of altered sediments and lavas, remnants of ancient rocks which were folded into mountain ranges, and then worn down to their base by millions of years of erosion. The mining prospector pays especial attention to these belts of altered rock, for it is in them that the ores of gold, silver, zinc, nickel, and other metals are found.

The Precambrian rock is overlain by sedimentary rocks, mainly limestone of Palaeozoic age, in two areas: one, circling the southern part of Hudson Bay from Churchill into Ontario, and the other, extending southwestward from Wekusko Lake as far as The Pas and Mafeking.

In more recent geological time the whole area was covered by thick ice-sheets which advanced, possibly four times, from nodal centres not far to the north and east and then melted back. As the ice advanced, the loose surface material which had resulted from previous weathering of rock was to a large extent swept away and widely scattered. Manitoba's history of glaciation explains the difference in mining methods from those practiced in the Yukon (which was not glaciated). In the Yukon, the various products of rock weathering were sorted by running water according to the size and weight of the particles, so that the prospector was able to "pan" gold from the river gravels. In Manitoba, on the other hand, these water-sorted deposits had been swept away by the glaciers, and when again deposited were so widely scattered as to be of no practical value. The metal miner here, as in other parts of the Canadian Shield, has to find what is left of "the mother lode", and practice "hard rock mining"; this involving the use of elaborate and costly equipment.

When the ice-front was static, morainic ridges were formed along the front or between separate glacial lobes. The so-called Pas moraine is the best known, running as it does from Long Point on Lake Winnipeg, westward, and then arching northward through The Pas. Another well marked moraine runs north and south along the Stull River, east of Gods Lake; a third extends northward from the vicinity of Thompson.

As soon as the ice-front had retreated over the height of land between the Nelson and the Mississippi basins, glacial lakes began to form in front of the ice, because of blocking of the northward drainage. The main lake, known as Glacial Lake Agassiz, covered much of the central portion of northern Manitoba including the Thompson area. In this lake was deposited evenly over hills and valleys a heavy deposit of clay and silt so that the area of the old lake is now known as the Northern Clay Belt.

Beyond the margin of the glacial lakes, rivers running beneath the ice have left a series of ridges, known as eskers, with direction at right angles to the ice-front. These ridges, which consist of sand, gravel, and boulders, are interrupted at intervals by glacial fans and outwash plains of sandy material deposited at points where the rivers emerged from the ice. Esker ridges are especially prominent in the district north of the Churchill River.

Another glacial effect is shown in the Hudson Bay lowlands which have a surface deposit of marine clay resulting from the sub-

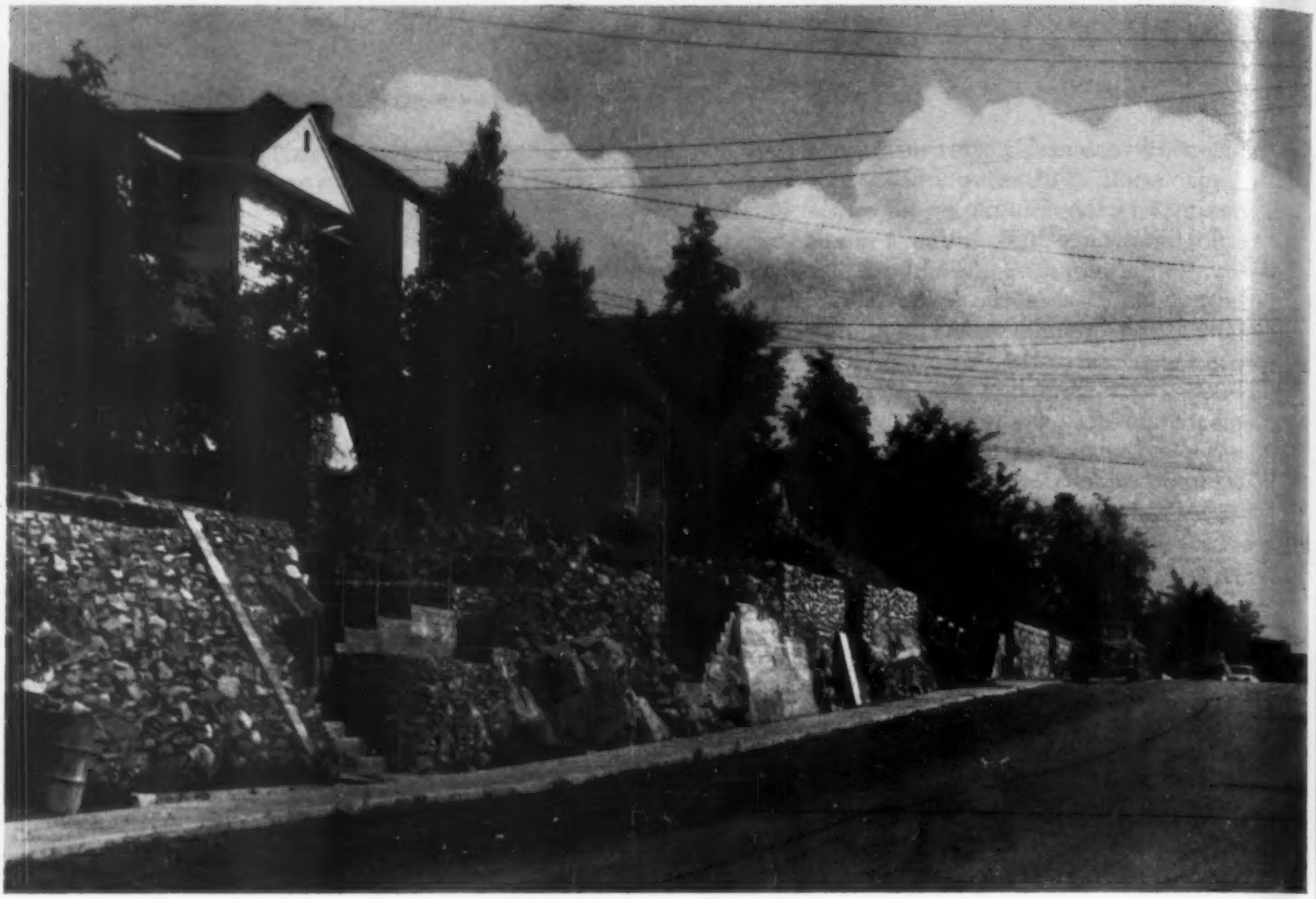
sidence of the earth's crust during the period of glaciation. This marine clay covers approximately the area underlain by the Palaeozoic limestones and extends inland to an elevation of about 425 feet above sea level in the region between the lower Churchill and the Ontario boundary. As the land gradually rose again above the sea, a series of marine beaches were formed, which are now the most conspicuous features of this lowland area.

When the lure of the Northwest Passage began to fade and the search for gold appeared unrewarding, English merchants turned to the fur trade, and in this they were shown the way by two native Canadians with years of experience in trade with the Indian tribes of the interior — Radisson and Groseilliers. In 1670 Charles II granted to the Hudson's Bay Company title to all territory draining into Hudson Bay, and their monopoly of trade lasted, in theory at least, until 1869. Unfortunately for the Company, but to the benefit of exploration, their monopoly was early threatened by French fur traders reaching inland from Montreal, and later after the fall of New France in 1763, by the traders from Montreal who formed the Northwest Company.

The Hudson's Bay Company's first post in what is now Manitoba was established at the mouth of the Nelson River in 1682, but the post soon moved to the adjoining Hayes River mouth, where Fort York was established in 1684 and occupied until 1960, although not continuously by the original founders. During the wars between England and France, it was captured by a French naval expedition, recaptured by the English, captured again by the French and held by them for seventeen years, being finally restored to the English in 1714, after the Treaty of Utrecht had ended the War of the Spanish Succession.

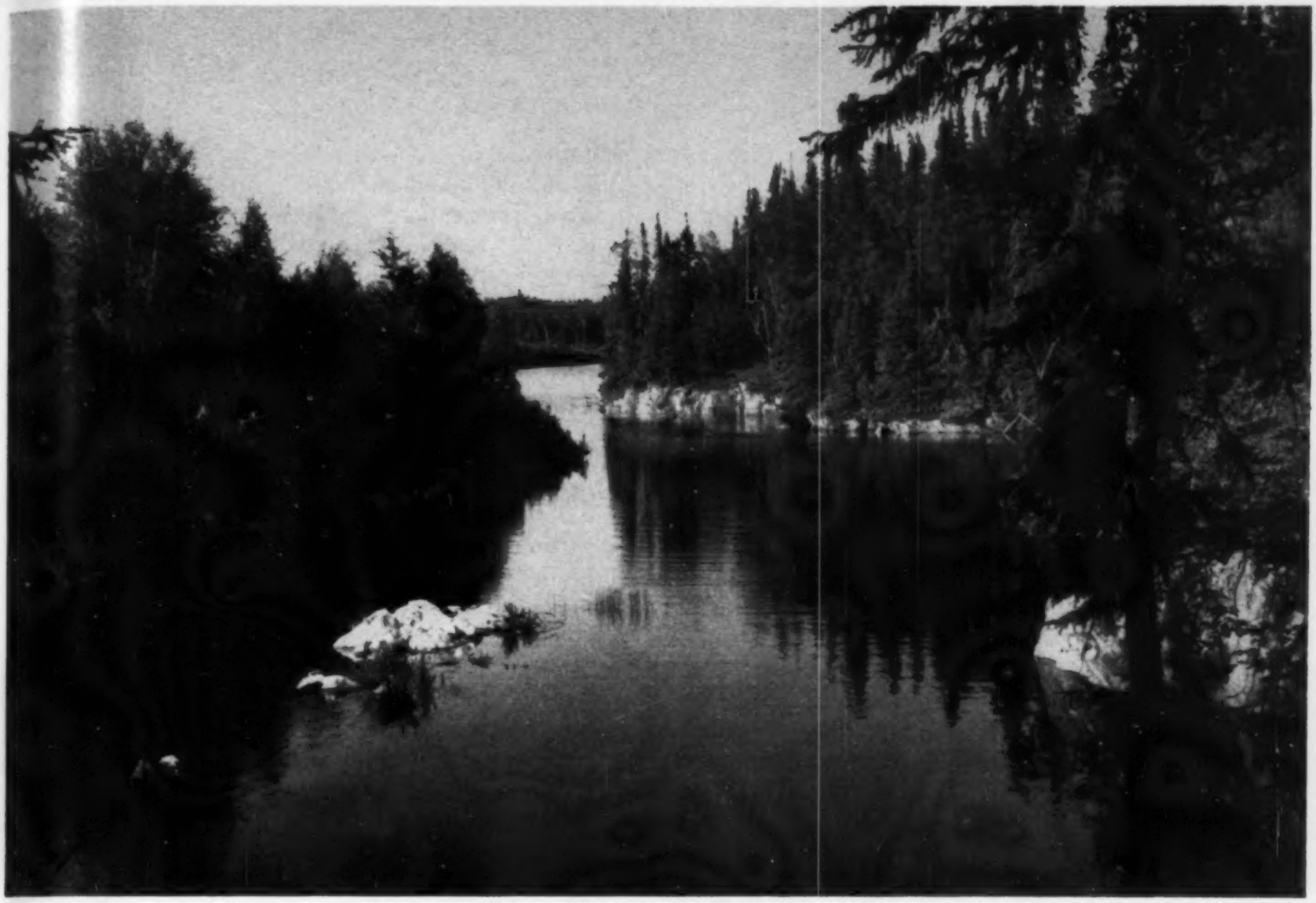
When peace was declared, the Hudson's Bay Company established a post at the mouth of the Churchill, and sent a number of expeditions inland continuing the explorations which started with Henry Kelsey's visit to the prairies in 1690-91. By 1742 La Vérendrye from Montreal was established on the

Highway No. 10 passes through rugged Precambrian country.



A residential street in Flin Flon.

Rapids on the Churchill River.



A northern waterway—Krug Lake, near Cranberry Portage.

Saskatchewan River at Cedar Lake, and it behooved the Company to further bestir themselves in order to meet the competition from Montreal, which became even stronger after the end of the French regime. This competition was countered for some time by sending traders inland to contact the Indians and bring them to York Factory, but this proving insufficient, in 1774 the first inland fort was established, Cumberland House, on the Saskatchewan. The founder of this post was Samuel Hearne, the man who had previously made his famous overland trip from Churchill to the mouth of the Coppermine River, and who later, during the American Revolutionary War, was forced to surrender Fort Prince of Wales at Churchill to a French naval force.

It was while Hearne was factor at Churchill that a young apprentice named David Thompson arrived from London. Later, while at Cumberland House he learned surveying, and henceforth his ambition was to map the country accurately. Previous explorers had been content to travel through the country in a spirit of adventure or for prosaic business reasons. Not so, Thompson; his passion was geography, and all through his career in the fur country, he kept notes of his journeys and made maps. When his own company failed to appreciate his work, he joined the Northwest Company which gave him every encouragement in his map-making activities. Before he retired, he had mapped and explored from Churchill to the Missouri, and from Lake Superior to the Pacific. It is fitting to note here that he at one time established a Hudson's Bay Company post on Sipiwesk Lake, and later a Northwest Company post at Southern Indian Lake, both of these posts in the general vicinity of the new townsite of Thompson, although this town was named after another Thompson, a pioneer in another sphere.*

In the fierce competition between the two rival fur-trading companies, water routes were all important, and the Saskatchewan river was one of the main routes used by both companies, connecting as it did both Hudson Bay and Montreal with the western plains,

*See article in this issue, "The Thompson Project".

the Rocky Mountains and the Athabasca country, so that an energetic fur-trader located on the lower Saskatchewan might divert to his own company the Indian canoes with their furs intended for his rival. The climax of the struggle came in 1819 when Governor Williams of the Hudson's Bay Company intercepted the eastbound Athabasca brigade of the Northwesters bound for Montreal at Grand Rapids, seized the furs, and sent the partners under arrest to York Factory. Two years later, the two companies found it advantageous to unite under the name of the older company.

After 1821, when the Hudson's Bay and Northwest companies united, the trade in and out of York Factory increased with the closing of the more expensive Montreal route. The main route for transportation of trade goods and furs for the western plains and the northern forest was by way of the Hayes and Echimamish rivers and through Norway House, and by this route came the Scots who established the Red River settlement in 1812. This situation continued until about 1858, after which date more and more traffic was diverted southward by way of St. Paul, Minnesota, and later by rail through eastern Canada.

Railways reached Winnipeg from the south and east in 1878 and 1880 respectively, but Manitoba could not be satisfied until she had a modern seaport on Hudson Bay connected with the agricultural south. Various schemes were put forward for a railway, or a combined rail and water route, but it was not until 1910 that the Dominion Government authorized the construction of a railway from The Pas and a seaport on the Bay. At first it was planned to use the estuary of the Nelson River for a port, and by 1918 the rails had reached Kettle Rapids and the Nelson River had been bridged at that point, and also further south at Manitou Rapids; while the grade had been extended to Port Nelson, and harbour work had commenced there. The open nature of the Nelson River mouth, and the expense involved in making a harbour which would be safe for shipping, caused second thoughts to be taken, and after a further investigation by marine engineers, the decision was made to divert the rail line at the Limestone Rapids of the Nelson, and to build northward from that point for a distance of 154 miles to the mouth of the Churchill River where a better port could be developed.

Due to interruption of work by the First World War and indecision with regard to the site of the port, it was not until 1931 that the

An experimental dyking and drainage project west of the Pas. P.F.R.A.

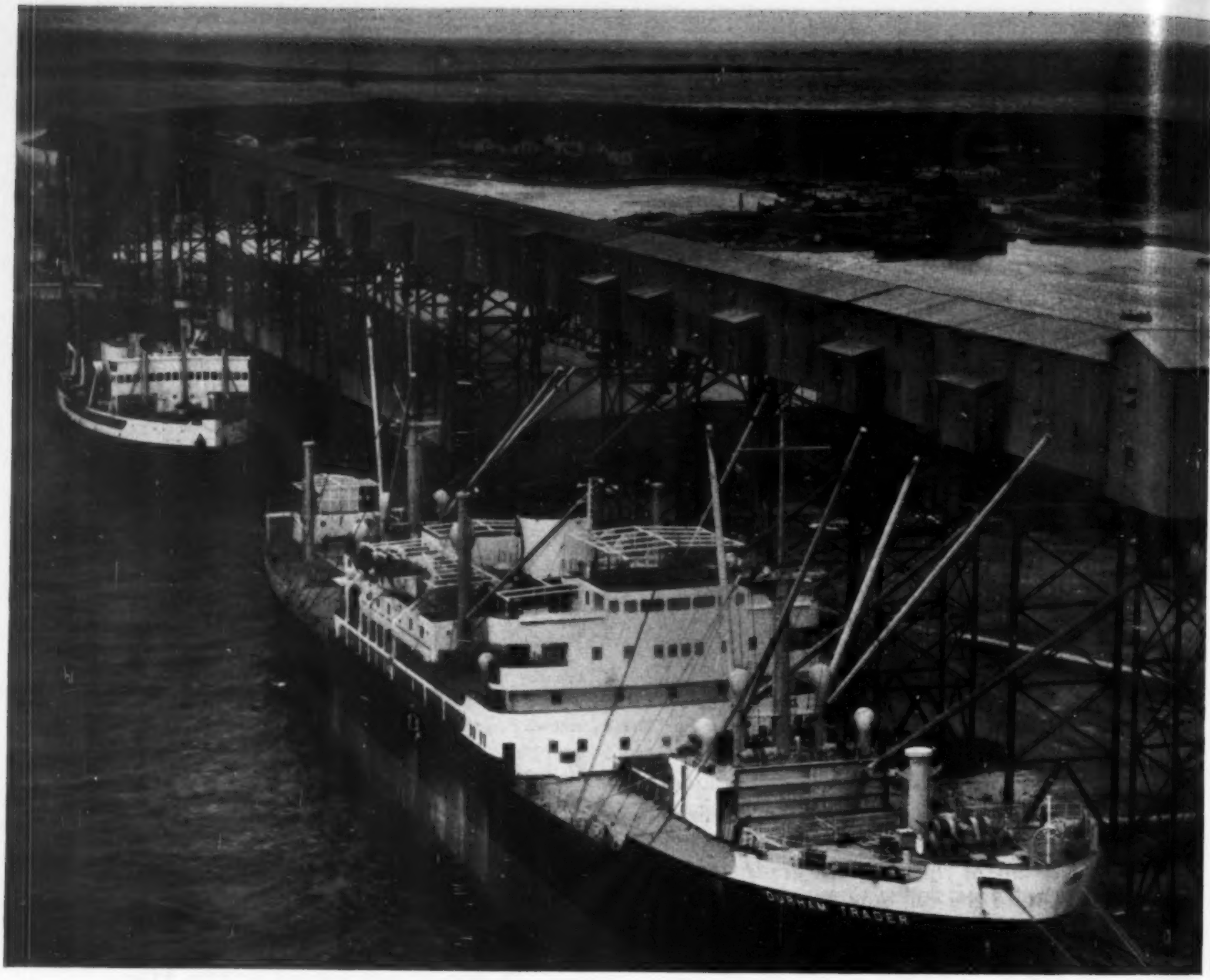
Aerial view of The Pas, a gateway to the north.

first two ships were loaded with wheat from the terminal elevator at Churchill. Since that time trade out of the port has gradually increased, and in the shipping season of 1959 a total of 59 ships took out nearly 22,000,000 bushels of wheat. In the same year, imports consisted of about 6,000 tons of general cargo from overseas, 37,000 tons of petroleum products and 23,000 tons of nickel-copper concentrate, the latter being en route from a mine at Rankin Inlet on Hudson Bay to a refinery in Alberta.

The main pressure which led to the construction of the Hudson Bay Railway came from the agricultural interests of Manitoba and Saskatchewan, hoping to get a cheaper outlet for farm products than was available over the long haul to the Atlantic seaboard, and little thought was given, at least in the beginning, to the development of the natural resources of the Precambrian areas which the railway would cross. As it happened, the line has been an important factor in the development of the mineral and other natural resources of the north. Even before the main line reached Churchill it became necessary to build branch lines to Flin Flon and Sherridon in order to serve mining operations at these points (the Sherridon line has now been extended to Lynn Lake). In the last few years other branch lines have reached Thompson and Snow Lake.

In northern Manitoba, highway construction has usually followed after railway building, in contrast to the usual sequence in other regions. Highways now extend to Flin Flon, Grand Rapids, and Snow Lake, and construction to Thompson is under way. The best hope for development of the more inaccessible areas seems to be linked up with the possibility of new and large scale mineral deposits being located. Judging by the presently mapped areas of potential mineral deposition, and the increasing use of geophysical methods of detecting ore-bodies concealed by drift, vegetation, or water, there is a good prospect that new mineral deposits will be discovered of such size that further highway and railway construction will be warranted. The Gods lake area, for example, produced $6,000,000 in gold between 1935 and 1943; prospecting for precious and base metals in this eastern area has recently revealed encouraging possibilities for future large scale development which will justify the building of a highway eastward from the Thompson road.

Agricultural development has been mainly confined to the flood plain of the Saskat-



Loading grain at Churchill.

Forest survey party packing two-way radio preparatory to moving camp.
Manitoba Forest Service

Northwest passage by air — passenger flights from Europe to the Pacific coast cross northern Manitoba.

chewan river, above The Pas; here, within a dyked and drained area, a promising settlement is being established. Further north and east, the climate may prevent the growing of any but the more hardy grain, hay, and vegetable crops (an agricultural experiment station has been established at Wabowden). There is a crop, however, which suits the climate, and that is the forest crop. The northern conifers — white spruce, black spruce, and tamarack, reach the shores of Hudson Bay at York Factory and Churchill. Jack pine is found at Nueltin lake; balsam fir reaches Split lake. Climatic lines in Manitoba run from southeast to northwest, and vegetation belts extend in the same directions. The forest tends to become more open as one travels northeast and is finally replaced by tundra north of Churchill. The belt of closed coniferous forest (with some poplar and birch) extends at least as far northeast as a line drawn somewhat north of Gods, Split, Southern Indian, and Reindeer Lakes.

Manitoba's latest forest inventory, completed in 1956 after five years of aerial and ground survey, shows that about seventy per cent of the province's coniferous wood is found north of 53° latitude (approximately Grand Rapids). Provincial forestry officials are satisfied that there is sufficient wood available in presently accessible merchantable areas of the north to provide a sustained yield to two modern newsprint mills, and at the same time allow a liberal expansion of existing sawtimber and pulpwood export industries. As for location, Grand Rapids on the Saskatchewan, and Sipiwesk Lake on the Nelson have been suggested as suitable forest industrial sites. Northern Manitoba is blessed with ample water power resources. Two large power developments are already underway, and other sites are available for development when required by industry.* The river-cut and lake-dotted northland is gradually being discovered by sport fishermen and others seeking recreation, and large scale commercial fisheries are established on the larger lakes.

In closing, one must not forget the ancient fur trade, which, with the introduction of better management, more particularly the introduction of the registered trap-line system, has greatly increased its output from a previous low level. And who shall say that the Northwest Passage has not been achieved, now that passenger aircraft fly from Europe, across Hudson Bay, to the shores of the Pacific ?

*See article in this issue entitled, "Kelsey: Power for Northern Manitoba".

The Honourable Duff Roblin, Premier of Manitoba, and J. Roy Gordon, President of the International Nickel Company of Canada Limited, are shown cutting a pure nickel ribbon signifying the start of production at the company's new nickel plant at Thompson, Manitoba, on 25 March 1961.

Three of the four converters at the Thompson smelter are shown here. At right, a huge ladle of converter slag is being poured into the return slag launder of one of the plant's three electric furnaces. At left, a ladle of nickel matte is being charged to a converter. Note worker at lower left.

The Thompson Project

by SYLVIA SEELEY

Photographs by the International Nickel Company of Canada unless credited.

The commemorative medallion specially struck for the dedication ceremonies at Thompson. It was designed by the Toronto sculptor Dora DePedery-Hunt, and depicts an engineer's dividers pushing back the northern forest to make way for the Thompson project.

ALONG THE path that leads to Canada's centenary of 1967 are many outstanding milestones which fully justify the faith of those far-seeing leaders who planned Confederation. In their wake has arisen in every walk of life a series of leaders to pilot Canada into projects of enterprise and energy that command the attention of the business world. After a long line of successes in industry where hand labour was the chief factor, the nation progressed into such specialized achievements as the Kitimat Project, (1954), Knob Lake, (1955), the St. Lawrence Seaway, (1959), and now the most recent of these advances in Canada's industrial life is to be found in the Thompson Project, where land that was an unprofitable wilderness in northern Manitoba as late as 1957 has rapidly been transformed into a community with the second largest nickel producing centre in the free world, 75,000,000 pounds a year. The founders of Canada's nickel industry have successfully realised some of the ideals of the Fathers of Confederation. They have put the same energy and foresight into business that the statesmen of a hundred years ago put into drawing up our country's constitution.

Every big mining company must always be on the alert for new fields of endeavour. Success cannot be maintained statically and the Directors of The International Nickel Company of Canada, Limited, know that however magnificent are the operations in the Sudbury district of Ontario, the biggest nickel works in the free world, the industry must continue to grow like all living things. On the cessation of the Second World War, industry became free to renew the search for fresh fields. As a result of developments during the war, airborne methods of ore detection beneath the surface were rapidly coming into use, which speeded up the discoveries of new orebodies. As early as 1946 attention had been focussed on the Canadian shield in northern Manitoba and the company resumed its prospecting with the aid of airborne devices by which ores can now be detected in the absence of geological outcrops where the metal lies sleeping far below the surface, unused and defying the earlier conventional methods of prospecting.*

In order to perfect these procedures, new airborne equipment was designed. Even so, the discovery of the ore in sufficient quantity was by no means plain sailing. The terrain was difficult and the surface teams who followed up the aerial findings had to be transported by helicopters, tractor trains, snowmobiles, muskeg tractors, and even canoes. The least accessible points could only be reached on foot. Patience, faith, and a great deal of money had to be stretched out over a period of ten years. Some fifty thousand linear air miles of aerial survey had been flown, and there had been headaches and heartaches enough over test drillings that proved abortive, but in 1956 faith and per-

*There is a model of this method on display at the National Aviation Museum, Uplands Airport, Ottawa.

severance won out and a big new orebody was discovered twenty-two miles southwest of Moak Lake, four hundred air miles north of Winnipeg.

It was on the fifth of December 1956 that the (then) Premier of Manitoba and Henry S. Wingate, (then) President of the International Nickel Company jointly announced the inception of a project for the development of the newly discovered orebodies and the project was to be named in honour of Dr. John F. Thompson who had just completed fifty years service with the company. Immediately following this announcement the company set to work with a will on the herculean tasks of felling trees, clearing land, building roads, and laying pipe-lines. Every particle of equipment from hammer and nails to bulldozers, from bread to blankets, had to be transported to the site over rough ground. By dint of running "the snowball express" twenty-four hours a day, seven days a week, the tractor trains moved thirty thousand tons of material during the winter of 1956-1957. The seventy-mile round trip over snow covered muskeg and frozen lakes took fourteen hours. It was a desperate race against time to bring in the power shovels, cranes, fuel oil tanks, building material and hardware of every description before the oncoming spring weather would render transport impossible. Work also proceeded apace on the thirty-one mile branch railway line which links the Thompson works with the Hudson Bay line of the Canadian National Railways line at Sipiwesk. This at once meant the arrival of more workers, more equipment and more materials, and in the period following, hoists were installed, shafts were sunk with narrow gauge transportation lines to connect them underground. There was heavy mechanized equipment to be moved into place; temporary housing and feeding facilities for 3,000 contractors' employees had to be erected on ground which offered peculiar difficulties. It was covered with supersaturated clay which had to be cleared away, for it was frozen rock-hard in winter, and became a quagmire as soon as the spring thaw had set in, making the transport of heavy material impossible.

In the course of road construction thus far north, one of the obstacles to be overcome is the permafrost. In this district the road builders found it easier to work while the snow was on the ground as it gave the machines better traction, and a heavy shovel, together with a ripper when necessary, had little difficulty in cutting through the permafrost to excavate for water and sewer mains. Wherever permafrost was encountered it was usually removed from the trenches and the space was backfilled with granular material. Sometimes, where the permafrost was exceptionally deep the trenches were undercut several feet beyond the normal grade and then backfilled. This was an accepted risk which proved to be about fifty per cent successful. In the building of roads it is necessary to guard against the possible results of subsidence or consolidation; also the builders must return to areas where permafrost has existed and add yet more granular material after the frost is out.

A row of new houses at Thompson.

A section of Thompson from the air. A portion of the business district is in the upper centre, and includes the municipal administration building, a hotel, the Manitoba Telephone System building, a theatre, and the Hudson's Bay Company store. George Hunter

At present there are twenty-four miles of provincial highway south of Thompson, six miles of road to the north connecting Thompson with the airport, and ten miles of road laid to the lakes, to the railway and to give access to the rivers. Within the town area of Thompson itself there are fifteen miles of roadway, which adds considerably to the amenities of the town for permanent residents. There is also passenger service six days a week by rail from Winnipeg. Three of these trains proceed on to Churchill while the other three return directly to Winnipeg. Air service between Thompson and Winnipeg on a six flights a week basis is also available.

It is obvious that newcomers to this district require some period of adjustment on arrival, specially if they come from the big cities where most household needs can be obtained at the touch of a button. But it seems axiomatic that a well-adjusted family unit remains well-adjusted irrespective of location, and at Thompson reasonable assistance is always forthcoming to aid a new family start life afresh in strange surroundings. The children appear to enjoy outdoor sports both winter and summer. The winters, though severe, are enjoyable on account of their dryness. As yet, no indoor recreation space is available with the exception of a two-sheet curling rink. No one appears to suffer unduly from the conditions of life, as the health records are favourable.

Business enterprise is just as free in this new mining town as it is anywhere else in Canada. Neither the International Nickel Company nor the municipality have any part in it nor sponsor it in any way. Each

Mining operations at Thompson. The man on the left drills holes for rock-bolting to support the roof, while the man on the right drills a round of holes in the ore preparatory to blasting.

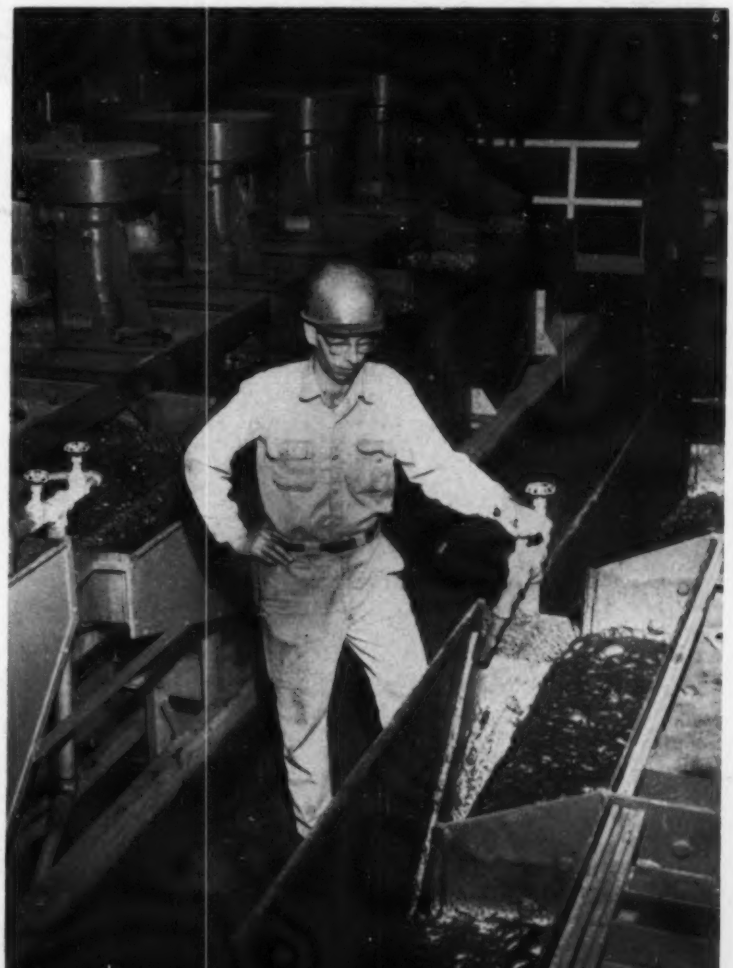
enterprise stands on the merits of the individual or firm who owns and operates it. Twenty-four business sites have been developed to accommodate fifty different types of business outlets, and in order that suitable homes should be provided for the ever increasing number of workers, application was made to the Metropolitan Commission of Winnipeg to draw up plans for the town of Thompson on a site within easy access of the works. This new mining settlement was to be no sprawling frontier outpost but a well-arranged town with residential and business areas designed for orderly growth and development. Plans for all communal facilities were set in order before the first house was built in 1958. Power for the new town and the mine was made available by the new Kelsey plant developed by the Manitoba Hydro-Electric Board at Grand Rapid on the Nelson River, fifty-three miles northeast of Thompson. The skyline of northern Manitoba is changing fast.

In order to effect the greatest economy of production all mining processes are mechanized by the newest methods. The production shaft was sunk to a depth of 2,100 feet; the development shaft was sunk to a depth of 1,057 feet. Between the two there are four connections at different levels and the work is chiefly by cut and fill mining. The broken ore is drawn to the stopes by the ore cars, and after crushing it is stored at first in an underground bin and then hoisted to surface storage bins. Minor quantities of cobalt, platinum metals, gold and silver are present in the ores but unlike those of Sudbury they contain very little copper. The valuable

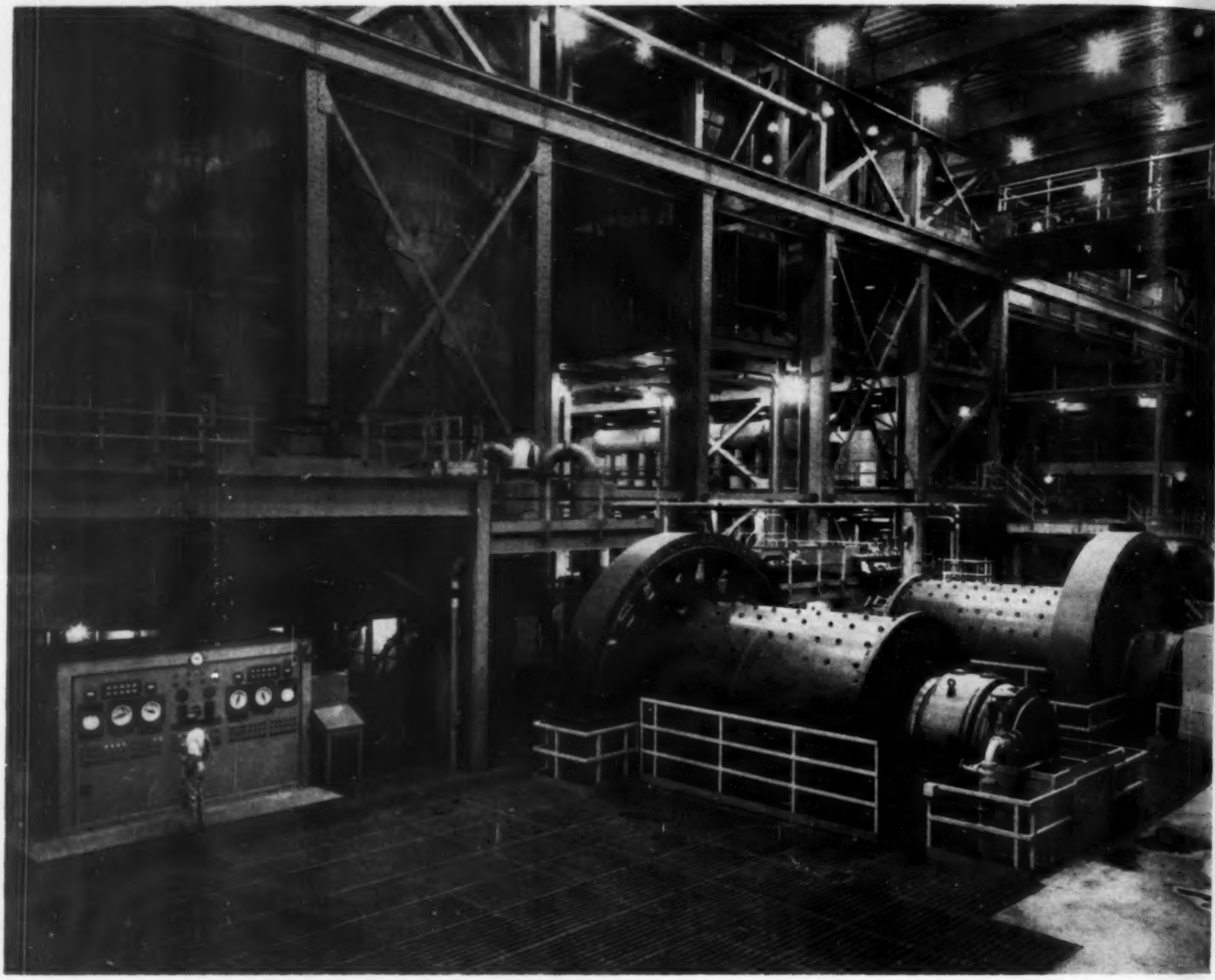
minerals in the ore are separated from the rock constituents by a flotation process. The nickel concentrate is then pumped to the Thompson smelter where it is thickened and then filtered and charged into one of three fluid bed roasters. Thence it is carried with the gas stream from the roasters into refractory-lined cyclones where the solid particles are settled out and dropped to the furnace feeding mechanism below. The roasted concentrates are smelted in three 18,000 kilovolt-ampere furnaces. The furnace matte is transferred in ladles by sixty-ton overhead cranes into one of four converters where iron is oxydized and removed as slag. The molten nickel sulphide or Bessemer matte is cast directly into refinery anodes. After cooling the anodes are dissolved electrolytically in plating tanks producing pure cathode nickel. This direct method is a recent development and has been used successfully at the Company's nickel refinery at Port Colborne in Ontario. The electrolytic solutions are treated for the removal of impurities and for the recovery of cobalt which is shipped as an oxide. Spent anodes together with an adhering high sulphur residue are crushed and washed. A filter cake obtained from the washings is melted and the sulphur is removed leaving a precious metals residue which is shipped to the Copper Cliff refinery for further processing. The cathode nickel is sheared in the refinery and shipped to markets in Canada, the United States, the United Kingdom and other industrial areas of the free world to be used for making stainless steel, for the electroplating industry and in making over three thousand alloys that are strong, tough and resistant to heat and corrosion.

All these satisfactory achievements are the end product of much planning and administrative work, which calls for the construction of suitably equipped buildings that must also have room for research laboratories, and engineering, metallurgy and geology personnel. There must be warehouses and workshops, generators and high pressure turbo-compressors and a power room for the power distribution system. In addition there must be changing houses to accommodate both miners and surface workers. All these facilities are provided on the most modern lines.

Situated just two miles from the plant and covering an area of 3,000 acres is the new town of Thompson where 2,200 men, women, and children have permanent homes. The initial plans provide comfortable living facilities for an anticipated population of 8,000, and there are temporary construction camps housing an additional 2,500 workers. The town is under the administration of the new local government district of Mystery Lake whose chief is appointed by the Provincial Government of Manitoba. As the International Nickel Company defrayed the cost of land clearance, town planning, the installation of all basic necessities such as drainage, sewerage, pure water supply, roads, sidewalks, fire station, fully equipped hospital and schools, the town has the unusual advantage of starting its municipal life free from debt, which means that taxation can be kept to a minimum for the present. The first elementary school was formally opened on the tenth of September 1959 with 144 pupils. A second elementary school was opened in April of

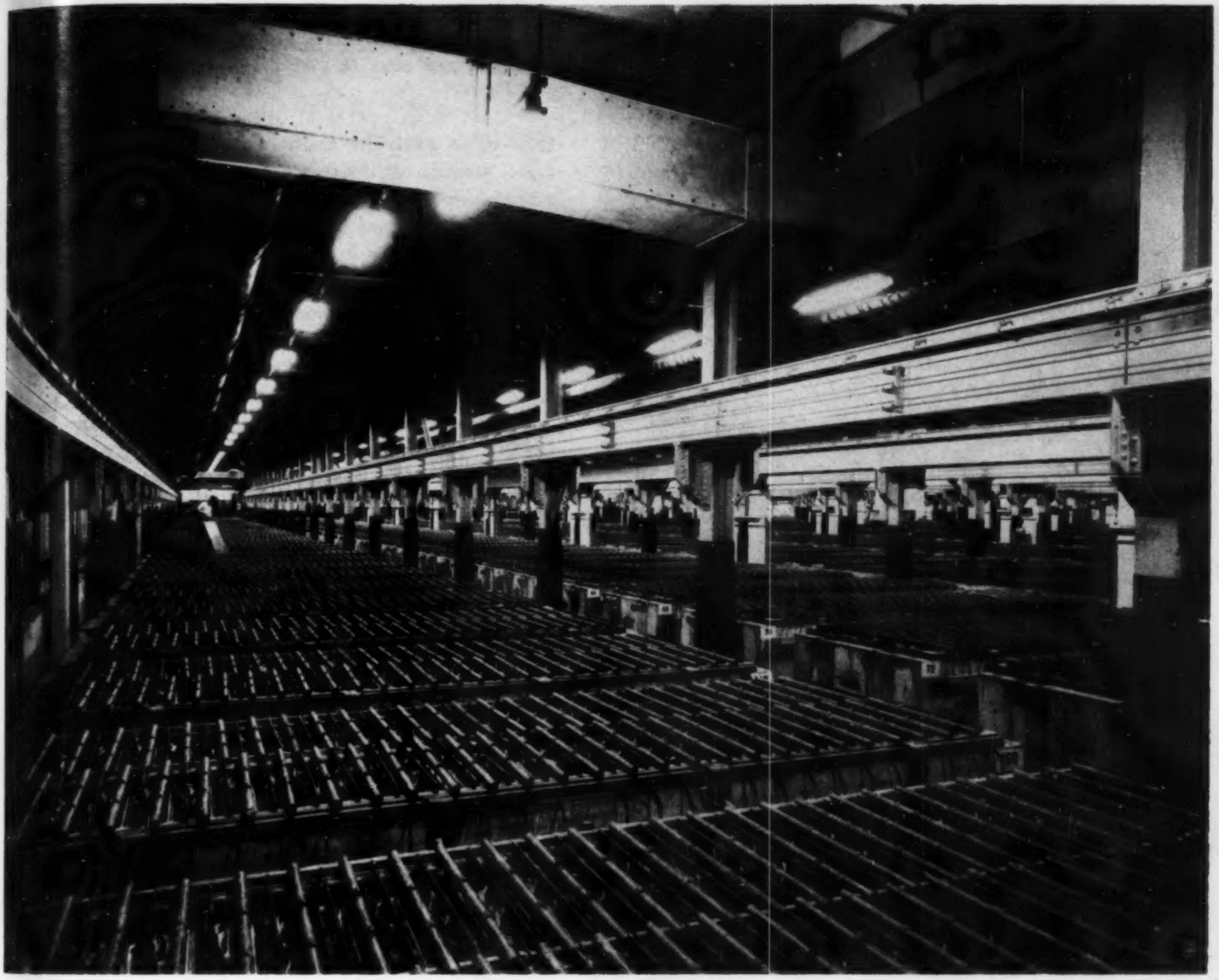


Flotation machines at the Thompson mill.



The concentrator at Thompson which contains the largest ore grinding mills in Canada, has a capacity of 6,000 tons per day. The grinding circuit is controlled from the panel on the left. Behind the panel is one of the three huge concrete fine ore bins, 56 feet in diameter and 63 feet high.

Interior of an electric furnace at the smelter.



In this refinery tankhouse, there are 684 nickel plating tanks, each containing 29 anodes and 28 cathodes. A unit man checks the quality of a nickel cathode halfway through its ten-day growth in a plating tank.

Inserting nickel starting sheets in the electrolytic tank at the refinery. The pure nickel is deposited electrolytically on these thin sheets.

At the formal opening of the first school in Thompson, children look over the stacks of books ready for distribution.

Centre:—a leathercraft class for adults.

Shopping at the meat counter in a supermarket at Thompson.

this year and the total student population now stands at 600, taught by a staff of twenty-five teachers. The first high school will be completed by November 1, 1961. The hospital, like everything else in Thompson, is designed for expansion and the same may be said of the churches, shops and recreation centres. The surrounding wilderness affords unlimited opportunities for hunting and fishing, and it is to the interest of the project that its workers should be contented and willing to put down roots in the new area.

With so much expense in outlay and development it is important for the company to assess correctly, as far as is possible, the probable quantity of ore that will become available for working and then to adapt the rate of procedure on lines carefully planned to avoid unduly rapid depletion of the ore-body. Examples are not lacking which prove the disasters that can be induced by want of such preliminary foresight. Ancient ghost towns give dismal proof of wasted effort in the heedless days of mining rushes when little regard was paid to the possible life of a newly discovered ore bed. Today, a well calculated rate of production is economically measured against the probable life of the mine to avoid premature exhaustion of the ore. This procedure also underlines the fact that the search for new locations of ore-rich terrain must be carried on all the time so that there will be some new enterprise ready to hand, as each ore deposit is finally worked out to the limit of its economic usefulness.

Another major factor in the success of any project lies in the question of demand and supply. The markets must be carefully watched, because new inventions and discoveries in other fields of labour may enhance or diminish the demand for any given product and mining production must be graduated accordingly, to meet any variations in demand. Without due regard to the supply on hand, and the variability of industrial needs, no mine can be efficiently run, and there must be a ready flexibility of policy and willingness to meet any industrial changes that may affect the demand for the metal or mineral in question.

The new output at Thompson has set the free world's nickel production capacity at an all time high. Exclusive of Cuban production

capacity which has ceased for the present to be available to the western world, it is estimated that the free world production will exceed 600,000,000 pounds by the end of 1961, of which Canada's contribution amounts to seventy-five per cent. Sudbury and Thompson together have an annual production capacity of 385,000,000 pounds. Scientific research is necessary to develop new nickel-containing products and new markets must constantly be sought with the aid of good merchandising, good advertising and all the modern accessories of sales promotion. The very wide range of uses to which nickel alloys can be put was made clear in an address to shareholders, given by Mr. Henry S. Wingate, Chairman of the International Nickel Company, shortly following the formal opening of the new project at Thompson. In the course of his speech he said, "On March 7, an experimental United States Government airplane — the X-15 — crossed the skies at the greatest speed ever attained by a manned vehicle, 2,905 miles per hour. The metal skin of the airplane reached a temperature of 700 degrees Fahrenheit during flight, yet retained its strength. This metal skin is made of 'Inconel X' alloy, one of a series of high strength, high temperature alloys developed by our research staff and produced in our rolling mills. As a commentary on the versatility of nickel, another nickel alloy we have developed is for use in storing liquefied gases at temperatures as low as 320 degrees below zero, Fahrenheit. This is a nine per cent nickel steel which we successfully demonstrated in 1960."

Further research has resulted in the production of an alloy containing eighteen per cent nickel as well as lesser amounts of cobalt and other elements designed to withstand exceptionally high pressure and stress. These new alloys help to create their own markets as they serve to make possible enterprises which could not have been attempted before their invention.

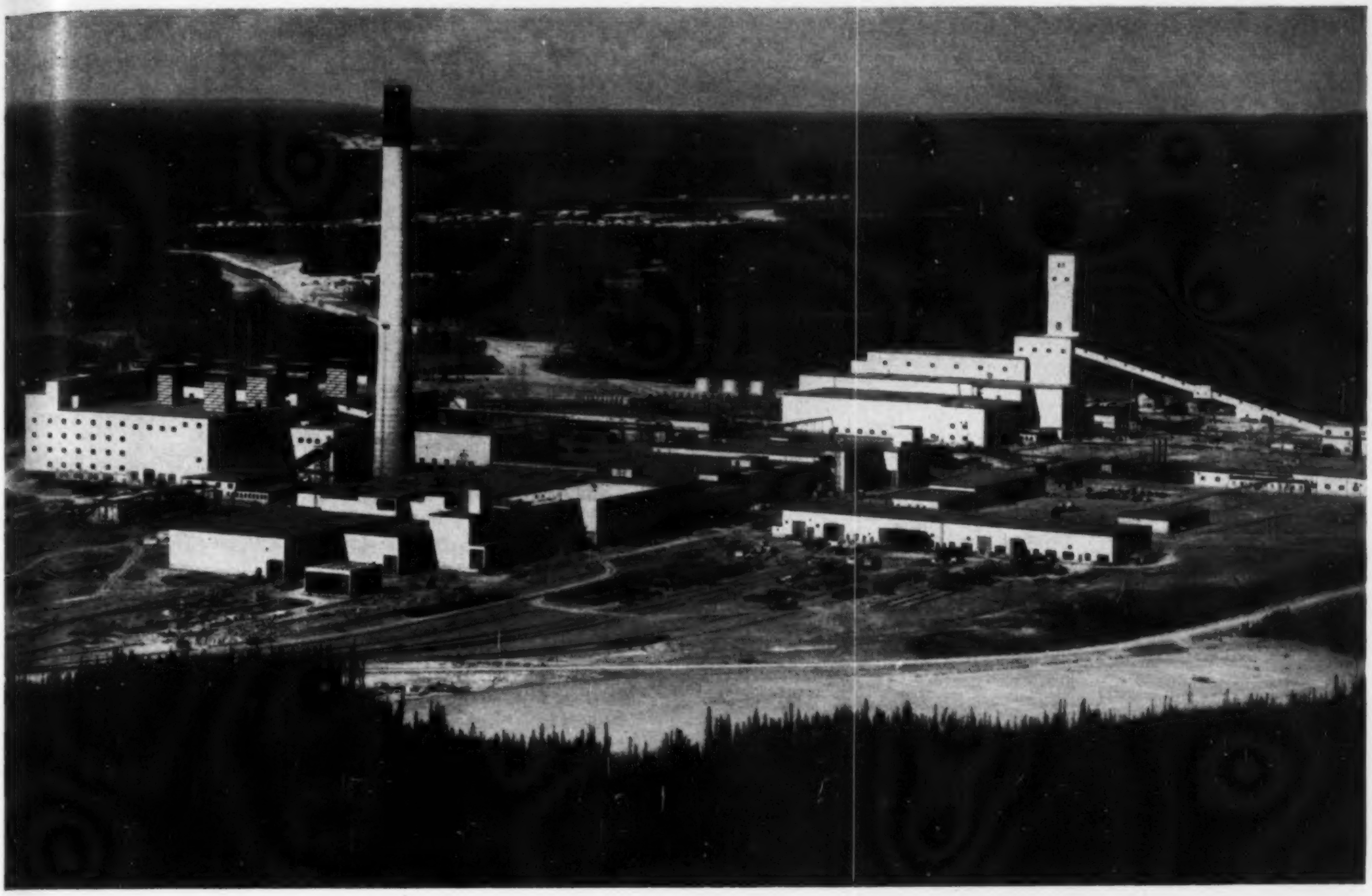
The new expansion of the nickel industry brought about by the Thompson project has the added value of providing employment opportunities for Canadians and immigrants alike and in Mr. Wingate's words, "It is also providing the basis for providing a still greater inflow of foreign exchange to assist in alleviating Canada's imbalance in international payments . . . It also encourages continued confidence in Canada's producers by demonstrating anew to nickel consumers that Canada is the world's most dependable source of nickel supply." This same point was also stressed by the Premier of Manitoba, Mr. Roblin, on the occasion of the opening of the new Thompson mine. In the course of his speech he said, "With the need to create new international markets to sustain our economic growth, the export of a finished product — electrolytic nickel — has important ramifications." He also recalled the fact that it was for the purpose of exploiting the fur trade in

Enthusiastic young hockey players at Thompson. The Thompson Athletic Association has formed ice hockey leagues.

Duck hunters on Paint Lake, near Thompson.

this very region that King Charles II had granted a charter to the Governor and company of adventurers of England trading into Hudson Bay in the year 1670. He pointed out that now, nearly three hundred years later, a lump of ore has replaced the fur pelt as a symbol of the richness and the potential of this great region, and he added, "We pay tribute to a Company of Mining Adventurers — men who without a government charter or special privileges from the Crown have paved the way for the permanent development of this frontier land." He also drew attention to the fact that because of this new development in Canada's nickel deposits, world attention had been rivetted on the northland, the province had experienced an

Swimming at Moak Lake, one of many lakes in the area where good boating and swimming can be had.

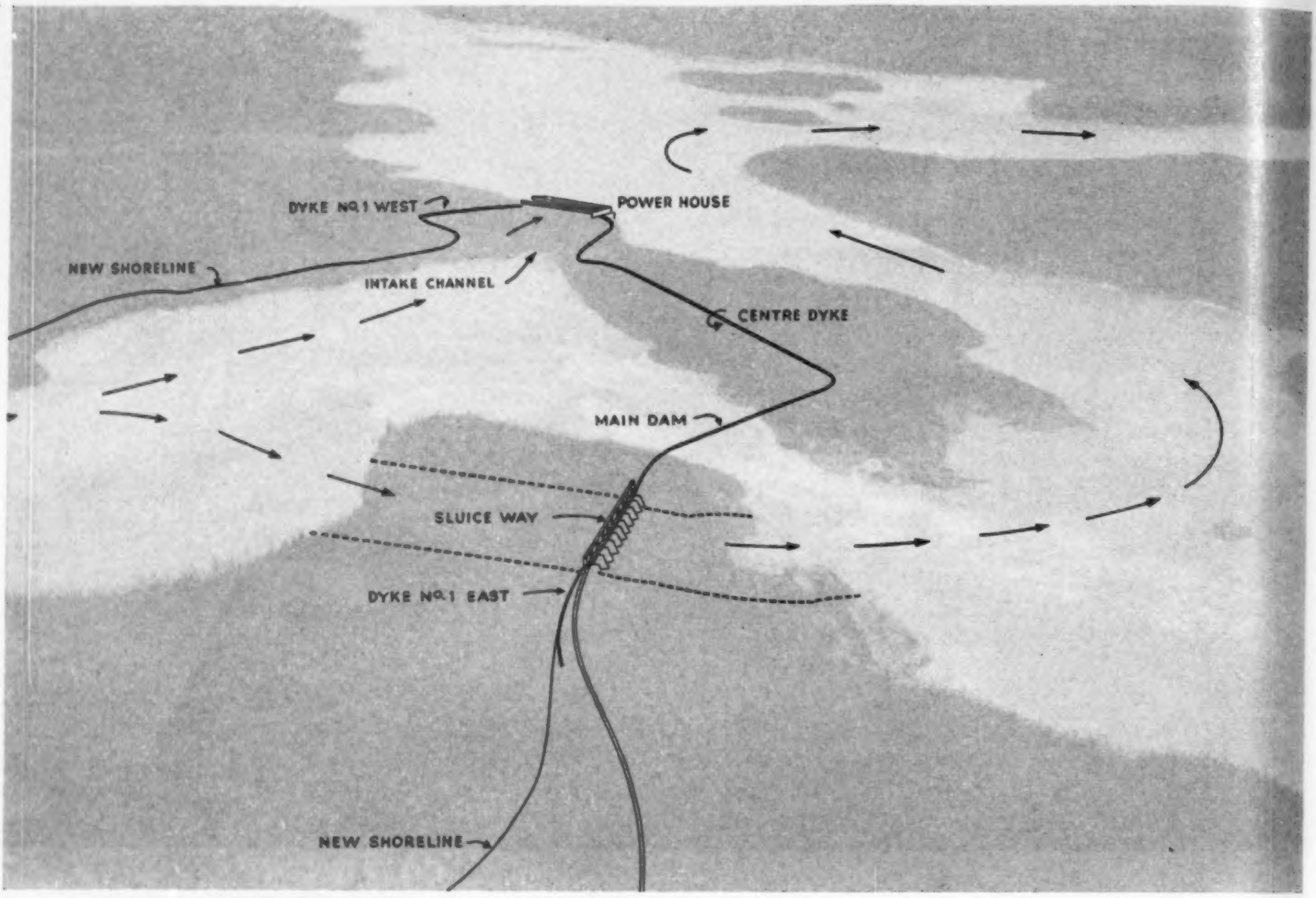


The Thompson mine and smelter works. The smelter stack towers 500 feet over the landscape; the building immediately in front of the stack is the refinery and on the right foreground are the shops and service buildings. The mine and mill are on the right, and the town itself can be seen in the distance.
George Hunter

accelerated programme of exploration. Because Manitoba desired to open this great new frontier economically, a new road building project has been planned to speed the work in this great wealth-producing area of the province.

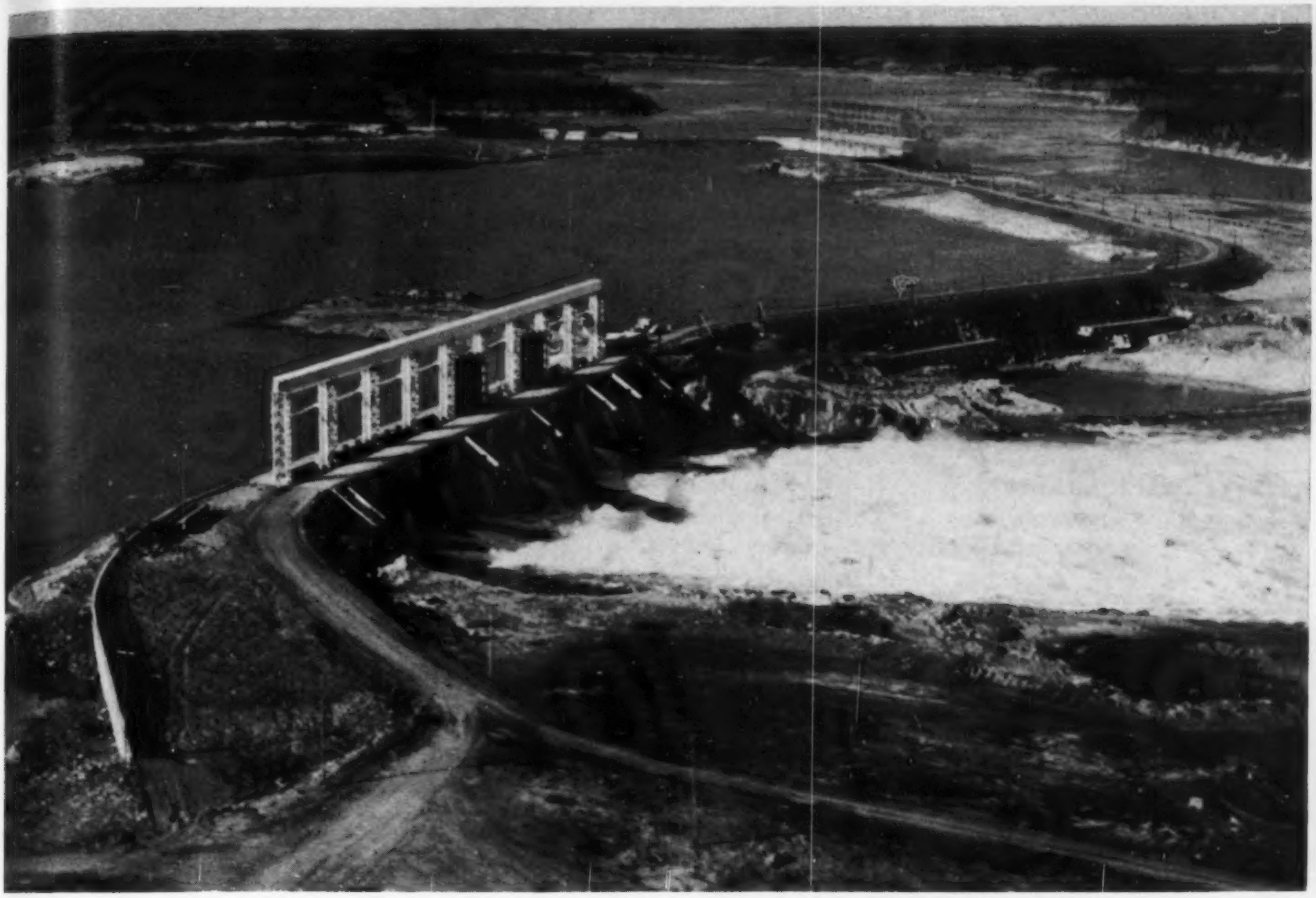
Although Canada is the world's leading producer of nickel, she is a very small consumer and uses only about one-fortieth of her own nickel producing capacity. The chairman of the company therefore emphasised the fact that all of the new output from Manitoba must be marketed outside Canada. The work of building up new markets in the United States, Europe and elsewhere is a vital companion enterprise to the mining itself, and will help to determine Canada's own international status in the industrial world, and her potential to meet the requirements of the age of space exploration.

The Municipal Building at Thompson.



A general view of Grand Rapid in its natural state, showing the general arrangement of development.

Cofferdamming during construction. The excavated spillway channel is in the foreground with spillway structure under construction. The main river cofferdam is being extended from left bank to divert river through spillway. Powerhouse tailrace cofferdam is shown top centre.



General view of the Kelsey generating station prior to the final raising of the forebay.

Kelsey: Power for Northern Manitoba

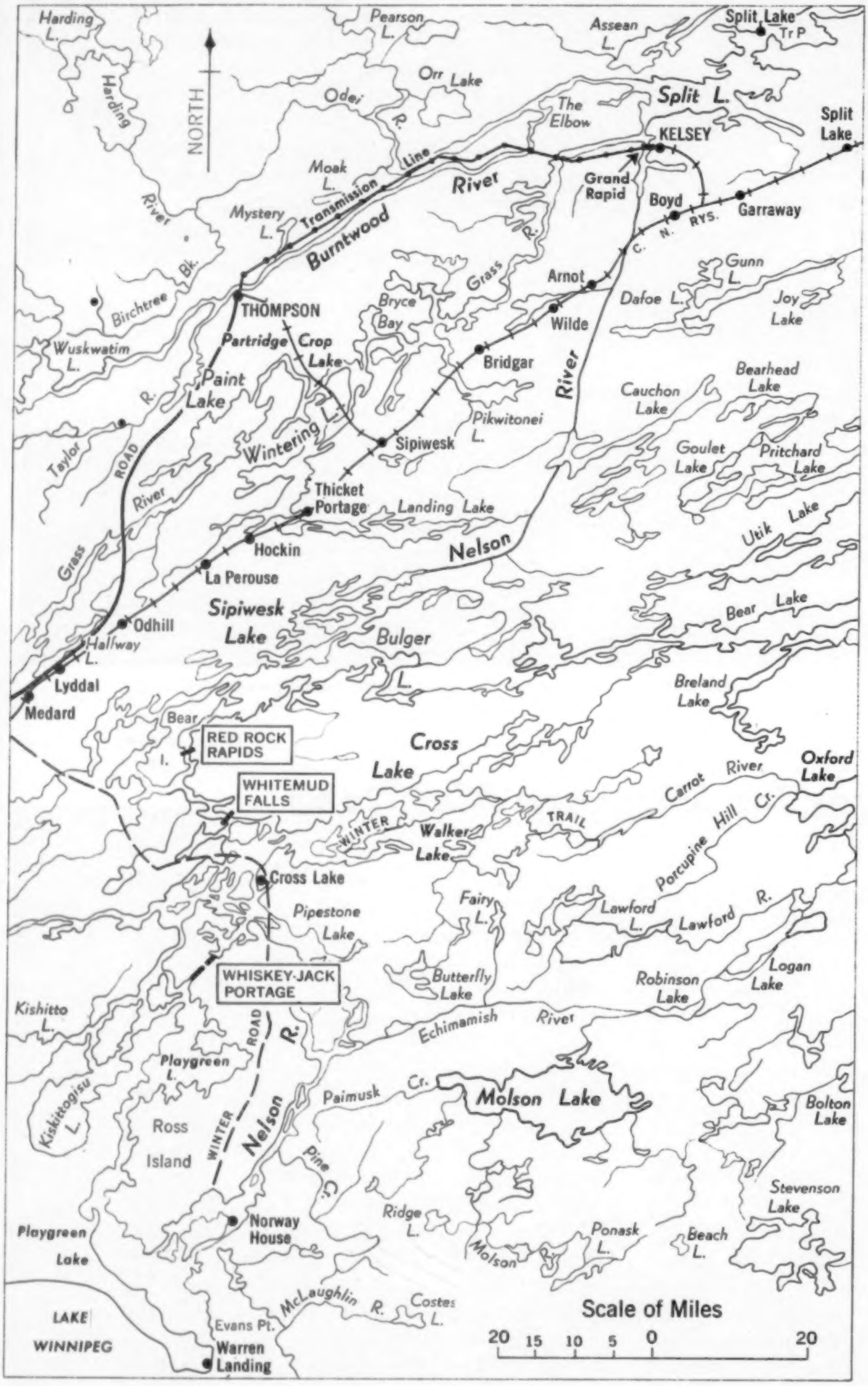
by H. R. HOPPER

Photographs by Manitoba Hydro.

How small a thing is man
In all that world-sown vast
That he should hope or plan
Or dream his dream could last!
—Bliss Carman

THERE is no known data which would suggest that Henry Kelsey ever saw the site upon which the Kelsey Generating Station was built. However, it seems only fitting that the first hydro-electric development on the Nelson River in Manitoba should be named to perpetuate the memory of the man who traversed the waterways of this area in the years 1690-91. From here Kelsey travelled further inland on the journey that was to establish him as the first white man ever to see the buffalo and ever to set foot upon the great Canadian prairies.

Except for the few scratches man has made upon the face of Manitoba's northland, the Nelson River today is much the same as it was in Kelsey's time, threading its course some 410 miles from Lake Winnipeg to Hudson Bay and draining an area which stretches almost half the width of a continent, from the head of the Great Lakes to the Eastern slope of the Rockies, and from the headwaters of the Missouri and Mississippi to the Churchill River basin. This area of some 414,000 square miles includes such river systems as the Winnipeg, Red, Assiniboine and Saskatchewan, all of which empty into the 9,400 square mile expanse of Lake Winnipeg. The very existence of this large body of water at the head of the Nelson River is one of the factors that make it one of the best regulated rivers in the world. The average flow at the outlet of the lake is 72,200 cubic feet per second (cfs) and the ratio of the highest flood flow to the lowest recorded flow is about 6 to 1. This does not match the less than 3 to 1



ratio of the mighty St. Lawrence, but this ratio will be approached once the outflow from the lake is controlled for power purposes.

Of the potential installed capacity of some 6,500,000[1] horsepower, available for development in northern Manitoba, about seventy per cent is on the Nelson River. The total descent of the river from Lake Winnipeg to Hudson Bay is 712 feet with the natural river gradient having no greater a concentration of drop than about thirty feet, yet feasible sites for power development exist throughout its entire length. In the upper reaches where the river flows through Precambrian formations, it consists of lake-like expanses connected by falls or rapids. At places, the banks are close together and provide good foundation conditions. In its lower reaches, the bedrock is overlain by glacial clay with gravel and boulders and the river is confined to a single channel. Available information indicates that foundation conditions are good but the clay banks and permafrost present problems in the construction of abutments and dykes.

This is the river that holds the key to the future development of

[1] Assuming 80% efficiency, 60% load factor and river flow regulated by storage.

Manitoba's north country, ever ready and waiting for man to create the need to harness some of its great power potential.

In August 1956, this need appeared when the International Nickel Company of Canada first showed active interest in a possible source of power for their proposed development in the Mystery-Moak Lake area.

The request for 102,000 KW of power prompted "Manitoba Hydro"[2] engineers to investigate and assess the suitability of several sites. The Burntwood River, into which Mystery and Moak Lakes drain, was not large enough to be considered and the nearest favourable sites were on the Nelson. Downstream from Lake Winnipeg, Whiskey-Jack Portage, Whitemud Falls, Red Rock Rapids and Grand Rapid[3] were all potential developments. Sites further downstream, being ever increasingly farther away from where the power was needed, did not offer any advantages over those already named.

The Water Control and Conservation Branch of the Province of Manitoba throughout the past years had conducted preliminary surveys at these sites. This information proved invaluable as it made it possible to evaluate the merits of each. Fortunately, the nearest site to the proposed nickel development was also the most economic and the decision favouring construction at Grand Rapid was not a difficult one.

It was August 8, 1956, when Manitoba Hydro engineers first saw the site of the future "Kelsey Generating Station" and were thrilled and well pleased with what they saw. The rapid is located four miles upstream from Split Lake at a point where the river, flowing north, turns a right angle toward the east and cascades through a narrow gorge. Immediately below the rapid the river reverses its direction to form a long narrow loop around a rocky peninsula. The difference in elevation of the water in the river on opposite sides of the neck of the peninsula was about twenty feet at normal summer water level. Suitable dams could raise the water on the upstream side about thirty feet to give a head of water of approximately fifty feet for a powerhouse at that location.

It was now evident that the preliminary data at hand would have to be supplemented with further subsurface investigation. Throughout September and October, a drilling rig was busy drilling holes to determine the depth of overburden and to prove the presence and location of bedrock. With this additional information, preliminary design work was underway and some thirteen different schemes for development were studied before the final layout was selected.

The chosen plan consisted of a powerhouse at the neck of the peninsula, a spillway channel with sluice structure and gates immediately southeast of the gorge, and a rock fill dam across the rapid. A number of relatively low dykes were required to retain the reservoir in low areas short distances upstream from the site.

It was mid-December before International Nickel Company of Canada announced they were going ahead with their development and although this decision was more or less anticipated, it spelled the end of speculative planning and precipitated the need for immediate and decisive action by Manitoba Hydro if they were to make the most of the 1957 construction season. First, it would be necessary to have access to the site ready by the time the general contract was let. This meant winter construction of a fourteen-mile railway spur from Mile 256 on the Hudson Bay Railway.[4]

Early in January, 1957, construction of the subgrade was started. Sub-zero temperatures made working conditions difficult but it was not long before a smooth operation was underway. It might be added that not only did schedule requirements dictate winter construction but also winter is the logical time for construction of this nature in this area. The reason is one of mobility. Construction equipment, trucks and other vehicles travel easily over frozen ground, whereas in the summer season they soon bog down and become immobile unless well constructed and durable trails are made available.

The grade, comprised of 277,000 cubic yards of sandfill, was completed by mid-April and the Canadian National Railways undertook to lay the steel. This work was completed by the first of June and the Access Railway was ready for use.

The General Contract for the Kelsey Generating Station was awarded on May 29 and men were clearing the site by June 10. One

[2] Known as "The Manitoba Hydro-Electric Board" prior to April 1, 1961.
[3] Grand Rapid on the Nelson River should not be confused with Grand Rapids at the mouth of the Saskatchewan River which is now being developed.
[4] Recently taken into the Canadian National Railways.

"PM3" was used during construction of Great Falls Generating Station on Winnipeg River in early 1920's. It was taken out of retirement and used at Kelsey until delivery of a new diesel electric locomotive.

Closeup of permafrost showing ice lenses. Vertical marks are from teeth of power shovel.

of the first jobs was the building of a complete camp and services to accommodate a minimum of 500 men. Prefabricated plywood insulated panel type buildings were used almost exclusively, and sewer, water and steam lines were placed above ground in insulated wooden boxes. This was necessary because the frozen nature of the soil would not permit conventional installation in excavated trenches.

The most interesting and unusual feature in the construction of the Kelsey Generating Station was the presence of "permafrost". Prior to the start of the work, "permafrost" was just a word associated with permanently frozen soil and its full significance was not appreciated by those on the job.

"Permafrost" is a term which has been used to describe perennially frozen ground and should correctly be used to describe all parts of the earth's crust which are consistently below a temperature of 32°F. Some sources of information state that approximately one-half the area of Canada and one-fifth the land area of the world is permanently frozen near its surface. Thus, as northern areas are developed, there is ever increasing concern regarding the characteristics and effects of permafrost.

With the definition of the term "permafrost" established, it would be relevant to relate some of the effects it had upon the work at Kelsey. The site is very near the southern boundary of the permafrost region and it was encountered in some shape, manner or form during construction in approximately seventy per cent of the entire area. However, its occurrence was found to be sporadic in both the vertical and horizontal directions and only in a small percentage of the area was the soil found frozen completely down to the rock surface. In some instances, permafrost was found in the rock.

Over half a million cubic yards of earth were excavated and the temperature and moisture content of the clay contributed to some of the most difficult problems encountered on the job. In permafrost, the moisture encountered (ice) was in one of two forms, either the homogeneous type in which the ice crystals hold the particles of soil together or the heterogeneous type in which the frost appears throughout the soil in ice fibres and ice lenses of varying thickness, sometimes in the order of six or seven inches.

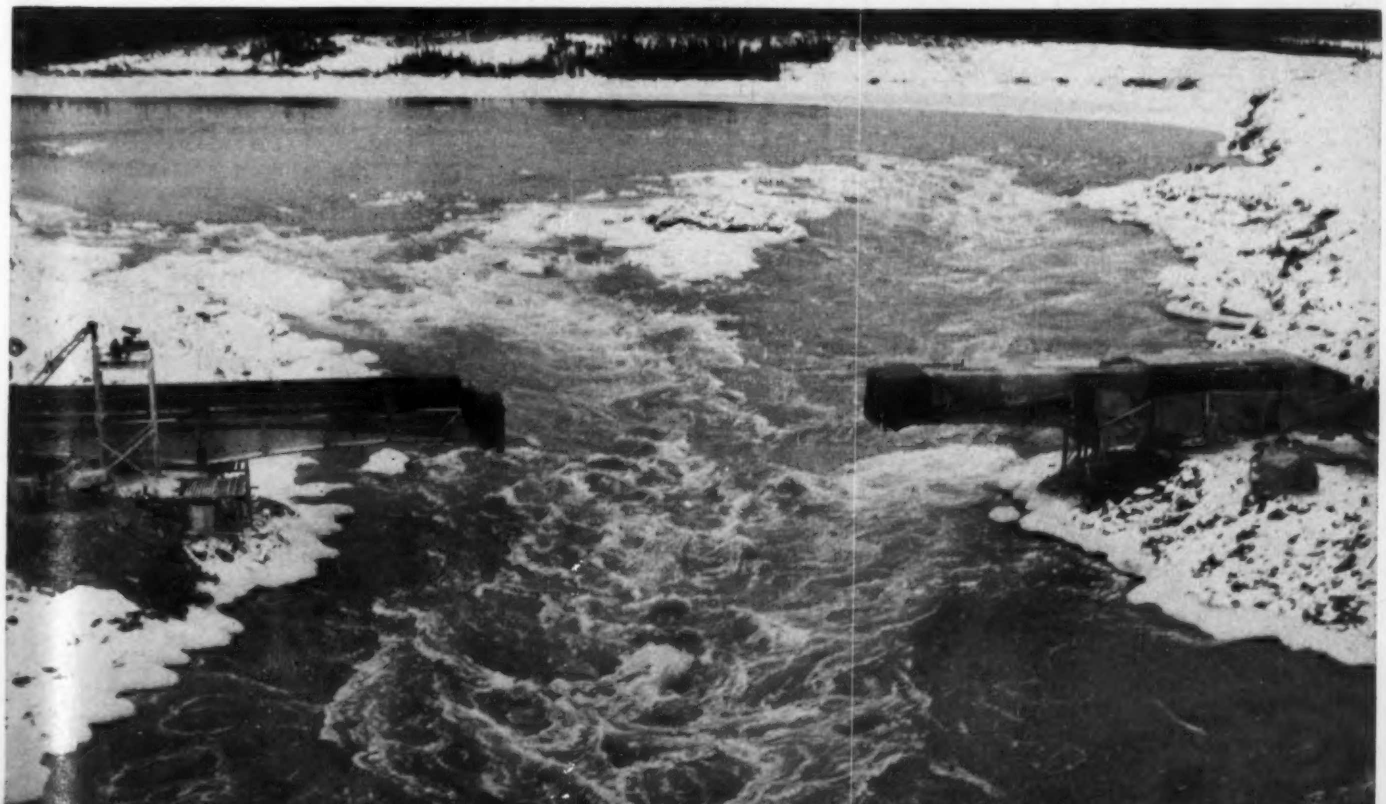
The temperature of the clay was from 29.5°F to 32°F, and as soon as it was exposed to normal summer weather, there was rapid thawing. This, together with the unusually high ice or moisture content turned the clay either into an unstable plastic mass or into a slurry of mud and water. Initial attempts at excavating the spillway channel consisted of stripping the upper surface down to permafrost and allowing the sun to thaw the frozen soil. The results of this procedure were as previously described and it proved almost impossible for equipment to move. Various types of drilling and blasting were then tried but the resultant lumps were too large to handle. The use of large power shovels finally proved to be the most successful method of excavation and it was by this means that the earth excavation was finally completed.

Coincident with the excavation of the spillway channel, work was also in progress on the construction of a bridge to provide access to the powerhouse area on the other side of the river.

The bridge was located at the narrowest part of the river and required a clear span of 245 feet over the most turbulent and dangerous part of the entire rapid. Several types of structures were considered but, keeping in mind both economy and schedule requirements, the decision was made to use a precast, post-tensioned, concrete bridge.

The original design provided for the entire bridge to be assembled from concrete sec-

The concrete cantilever spans of the post-tensioned bridge are in place. The steel centre span is being assembled on the section at the left of the picture.

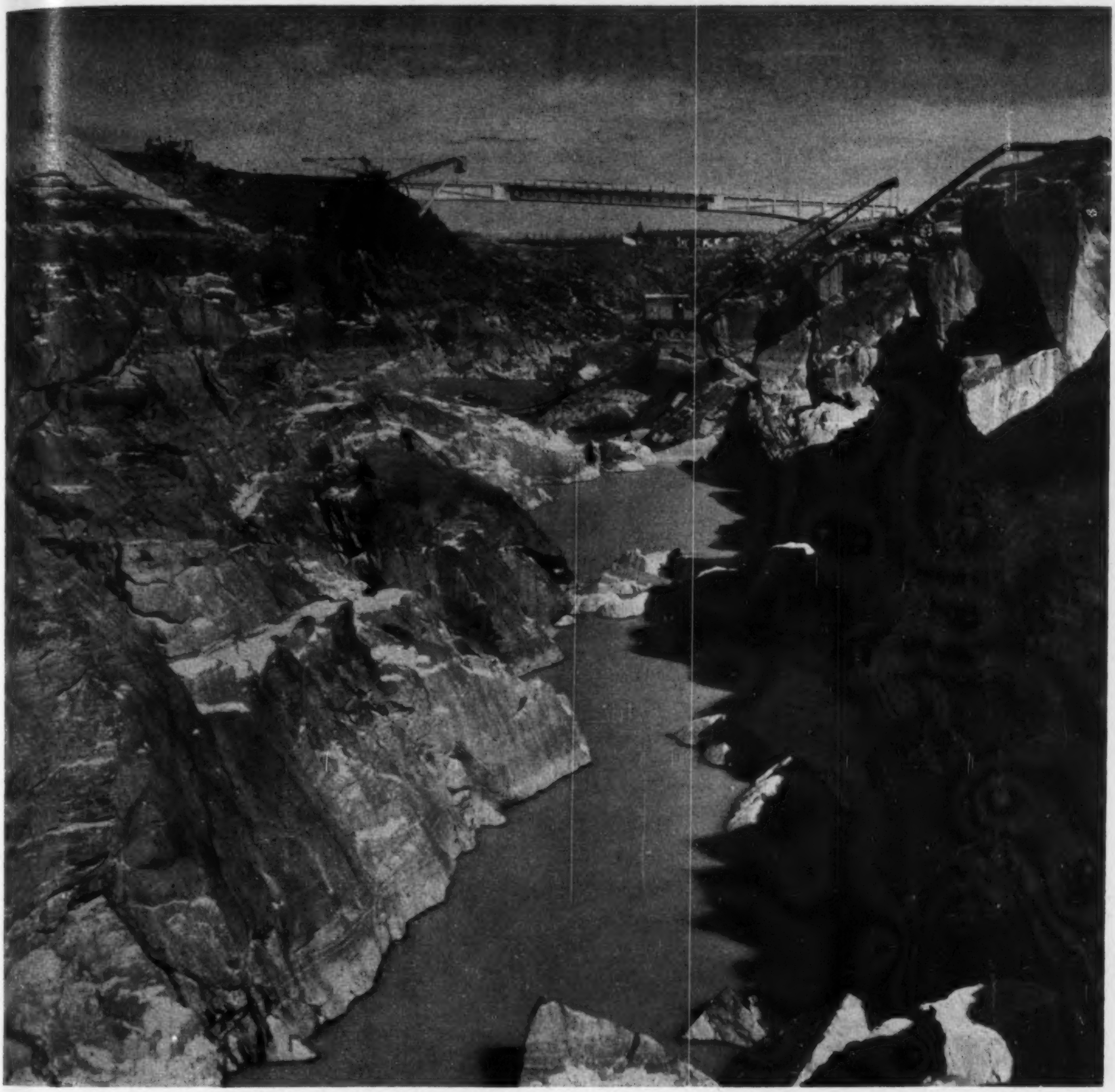


tions, but due to the fast approach of winter and contemplated erection difficulties, the design of the centre portion of 110 feet was altered to incorporate a deck plate girder span. The concrete portion of the bridge now consisted of two 120-foot sections, one on each side of the river, each cantilevering out over the river. The sections were first assembled from segmental precast sections, manufactured in St. Boniface, Manitoba, and were transported to site by rail. These sections were up to fifteen feet in length and from eight to sixteen tons in weight. After assembly, they were drawn together to act as a single unit by tensioning high tensile steel wires, in much the same manner as one can draw together into a single unit a row of child's blocks by stretching an elastic band tightly around them. The assembled units were then jacked out over their respective abutments and piers, on specially constructed runways, where each unit formed a sixty-seven-foot, six-inch cantilever span out over the river. The steel girders were then placed in the remaining 110 feet and the bridge was ready for use on December 4, 1957, approximately two and a half months after the start of erection.

At one time or another, on every hydro-electric project, it becomes necessary to divert or control the flow of the river to enable the construction of the main structures in "the dry." This is accomplished by cofferdamming, an operation which consists of placing a watertight structure in the river around the area of the work and then pumping out the impounded water, exposing the river bottom.

The sequence and method of cofferdamming at Kelsey was given a great deal of thought and study. Visualize the problem of diverting an entire river with a flow of such magnitude and velocity that if one were to drive a three-ton truck into the river, it would be immediately swept downstream several hundred feet. The answer came as the result of theoretical investigations, model testing, observation of some prototype cofferdam closures and the study of reports on others as well as evaluation of the effects of topography, river flow and other features and phenomena

Cleaning foundation rock for main dam. Note large circular pot-hole eroded by action of boulders being swirled around by turbulent water. Some rocks were worn to perfect, smooth spheres. There were several such holes of varying sizes in this area of the rapid.



Unwatered river channel at the location of the former rapid. In the background, construction of the main rockfill dam is underway. The bridge is located immediately downstream.

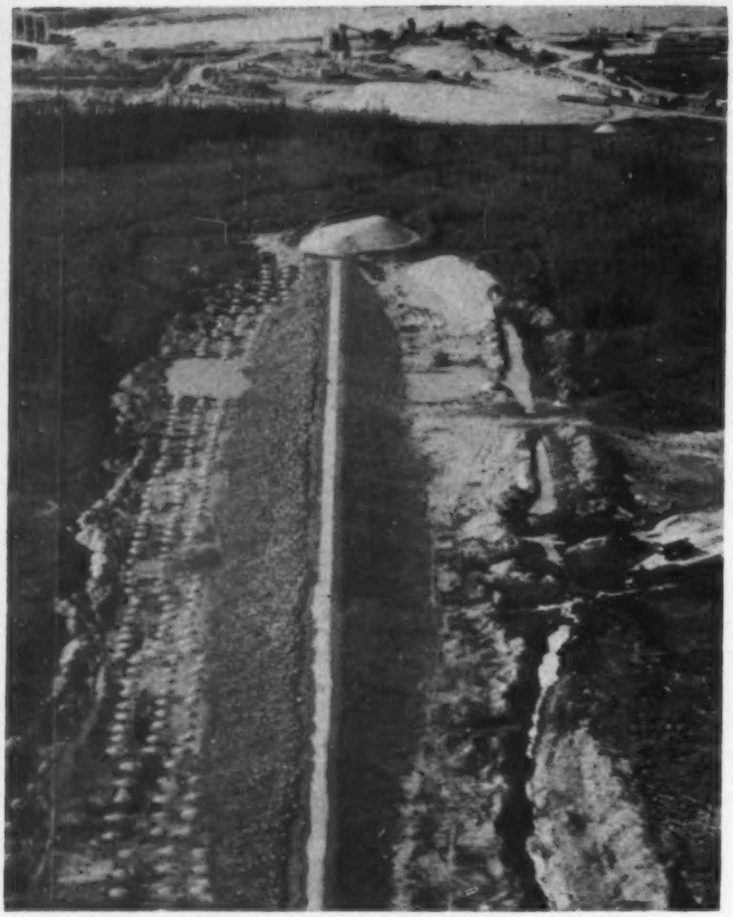
that could affect cofferdam construction.

The construction program required that the spillway channel and structures be completed by the end of 1958 and that the Nelson River be diverted through the spillway by April, 1959, so that construction of the rockfill dam across the rapid could be completed during the summer of 1959.

This schedule had to be adhered to rigidly, otherwise the project could not be completed in time to meet commitments. Kelsey's very existence is the best proof of the successful execution of these plans.

The spillway and main river cofferdams were of the rockfill, earth seal type while the powerhouse tailrace cofferdam was a conventional rock-filled timber crib with steel sheet piling.

The purpose of a spillway structure is to control the water level of the forebay within predetermined limits. Once the desired forebay elevation is reached by impounding the water, a constant level may be maintained by operating the gates at suitable openings so that only the surplus river flow is spilled. At times of flood flow, this surplus may be of



Dyke No. 2 East constructed directly upon permafrost. Grid of vertical sand drain holes on left also extends under dyke. Seepage ditch is on right.

great magnitude and the discharge capacity required in a spillway has to be sufficient to handle not only the greatest flood on record but also the maximum probable flood that could ever be anticipated.

No two rivers are alike and each site has to be studied separately and conclusions drawn from existing data on river flow and known characteristics of the river basin. The design flood for the Kelsey site is 250,000 c.f.s. and this can be accommodated by the nine 40 feet by 42.5 feet vertical lift sluicegates.

The Kelsey project involved the construction of a small rockfill dam and a number of dykes which, because of the climatic and geological conditions at the site and schedule requirements, gave rise to some geotechnical problems of unusual interest. The most significant factors were the low mean annual temperature, the short annual period of temperature favourable to earthwork construction, and the existence of appreciable but sporadic permafrost throughout the site. Construction of the main dam was governed by a reasonably tight diversion schedule and a short construction period. Some difficulty was experienced in the use of a fairly plastic wet clay for core construction and extreme difficulty was encountered with the very low temperatures existing during the later stages of its construction.

By late September, difficulty was experienced with freezing of the clay and to overcome this, calcium chloride was added to the fill as it was being loaded at the borrow pit.

Freezing continued and frequent delays resulted from the need to stop placing and to scrape off as much as six inches of frozen clay from the surface. In this manner, the fill was placed until early October, at which time the daily range of temperature was approximately 22° to 35°F.

The temperature continued to drop, but the need to complete the dam before March, 1960, led to the decision to finish the core placing under a heated enclosure. A timber framework, 19 feet wide and 96 feet long was built and covered with polyethelene tarpaulins. Heat was supplied within this enclosure and the placing of fill recommenced on November 6 and continued as the cover was moved along the dam until the fill was completed on November 22.

About one-half mile upstream from the dam on each side of the river were two low swampy areas where it was necessary to construct two dykes each about 2,000 feet long and each having a maximum height of about twenty feet. Permafrost was predominant but not continuous in this area and it was realized that once the water was raised and the area flooded, the entire thermal regime would undergo a change, and thawing would take place, leaving a plastic mass with little or no bearing capacity. How then could a water retaining structure be successfully built on such a foundation? The choice of constructing dykes where permafrost was not present did not exist; neither was it practical to excavate the undesirable material nor to preserve it in its natural state by artificial means. The resulting design has no known precedent and provided for the construction of sand dykes upon the existing overburden. Special features were incorporated to accommodate anticipated settlement and movement.

Considerable interest has been shown in the performance of these dykes and the Division of Building Research of the National Research Council of Canada in conjunction with Manitoba Hydro have set up a program of instrumentation, designed to measure the changes in the thermal regime and the resultant settlements of the varved[5] clay foundation beneath the dykes. The significance of the results will not become apparent for some time, but will be of the utmost importance in the future design and construction of dykes under similar circumstances.

By January, 1960, the main concentration of work was within the powerhouse and progress on the whole was good. In fact, one could not help but feel that the project was on the home stretch and the commissioning of two units to meet the schedule date of July 1, 1960, would now be routine. There was no reason to think otherwise for had not all of the difficult problems been overcome? The completion of the main dam under adverse weather conditions, the construction of dykes on permafrost, the excavation of permafrost, the main river cofferdam closure and river diversion, the erection of the bridge and the construction of the access railway were each major tasks by their own right and they were all now behind. It would not be long before the first of five 42,000 horsepower propeller type turbines would be driving its coupled 37,500 KVA generator. Generation would be at 13,800 volts and by means of five large transformers on the tailrace deck, the voltage would be raised to 138,000 volts for transmission to Thompson over a fifty-nine-mile long double circuit line mounted on steel towers. The "monthly report" for January, 1960, would be good.

On Saturday, January 30, 1960, at 10:45 a.m., the Engineering office of Manitoba Hydro in Winnipeg was particularly quiet as clerks and stenographers were off work on their normal weekend. A handful of engineers was working those extra hours that are so often necessary. The quiet was suddenly ended by the mechanical clatter of the teletype spelling out a message:

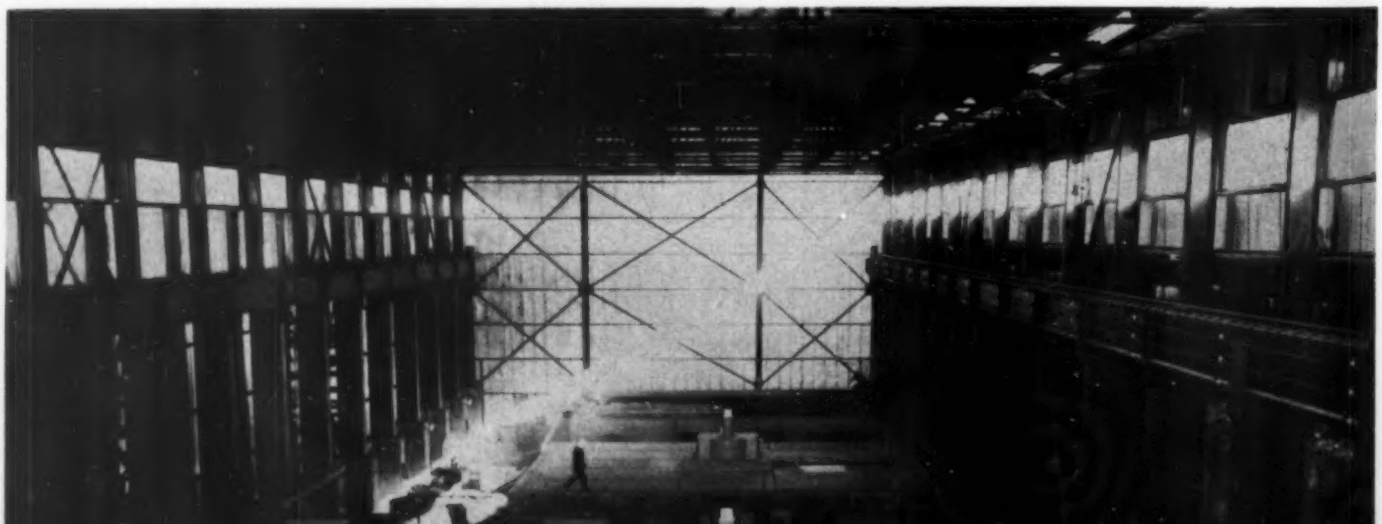
"Powerhouse on fire.
Fear Total Loss."

[5] i.e., stratified in layers of annual deposition.

Excavation of permafrost in spillway channel, illustrating effect of exposure to summer heat. The firm material being excavated at the right will turn into the plastic state at left after a few days.

The completed powerhouse. The forebay level is about eight feet below design level.

Interior view of the powerhouse showing Units 2, 3, and 4.



To those on site who were watching the holocaust, this message looked all too true as columns of thick black smoke and orange flames were pouring forth from the entire 450-foot length of the roof. The teletype was now in constant use, producing a steady flow of questions and answers, and giving a running commentary of happenings at the site. Finally at 1:45 p.m., the following message was received:

"Fire in powerhouse now under control. Very extensive damage to roof, wall cladding, superstructure steel, powerhouse crane — still not known what damage to units one and two and house units."

It was now evident that hard times at Kelsey were by no means over. The whole powerhouse was open to the elements. Temporary enclosure and heat had to be immediately provided for and even when this was completed, temperatures within the building were such that water froze immediately upon application to the powerhouse concrete walls when an attempt was made to clean them.

It is to the credit of all those on the site, who through their hard work and ceaseless efforts under the most difficult circumstances and rigorous winter conditions, and also to the co-operation received from the suppliers of major equipment that in the period of the next few months rehabilitation work was carried out with such vigour and enthusiasm that the commitment of two units on line by July 1st was not only met but was bettered. Unit No. 1 went on line June 22nd and Unit No. 2 was ready on June 30th, 1960.

Today, the Kelsey Generating Station bears no scars as a result of the fire. All five units are in operation and remotely controlled from Thompson, 59.7 miles away.

The installed capacity of 210,000 horsepower is about half of the ultimate potential of the site and although Kelsey does not rank among the largest of power developments, nor can its setting be classed among the most spectacular, it can lay claim to being the largest remotely controlled station in the world and also controlled from the greatest distance of any known station. In addition, the volume of permafrost excavated has probably never been exceeded and the construction of sand dykes directly upon permafrost is without precedent.

When everything is taken into account, we would claim that the construction of the Kelsey Generating Station ranks as one of the most challenging, the most fascinating and the most interesting of developments.

Nelson River at the foot of the spillway channel during diversion. The construction camp can be seen in the distance.

A snake — the familiar symbol in many native cultures throughout the world — is outlined realistically with rocks in the Whiteshell Forest Reserve of Manitoba.

Rock Serpents of the Whiteshell

by ADELAIDE LEITCH

Photographs by the author

An enormous serpent of Ojibwa legend sprawls over the rocks of the Whiteshell Forest Reserve on the Manitoba-Ontario border.

Stones hoary with grey-green lichen outline its 300-foot length, and a flat, triangular rock forms a curiously realistic head. Today, some of the rocks have been moved in this and other outlines of the Whiteshell Mosaics, but enough remain to plague experts with speculation.

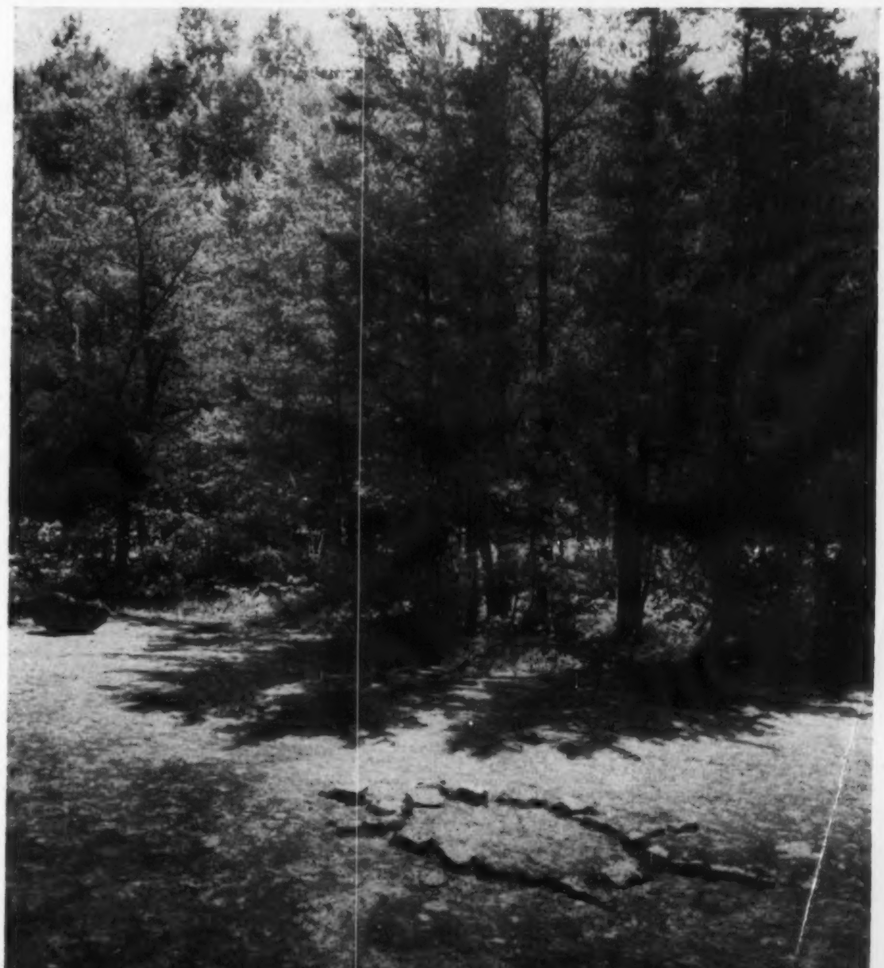
Figures such as these — the snake, the turtle, the birds and other creatures outlined by the stones — may have been used by medicine men in performing rites from which they obtained their medicine. In the Whiteshell itself, there are a number of these 'ceremonial areas', most of them inaccessible to the casual visitor. They also occur elsewhere in Manitoba and Saskatchewan, as well as in the north-central United States.

When the Historic Sites Advisory Board of Manitoba marked the Whiteshell Mosaics, it erected a rustic gate, on which was outlined a probable purpose of the Mosaics — and a reminder to 20th century visitors:

"You are about to enter a ceremonial ground of the Ojibwa (Salteaux). This area was a sacred rendezvous where they sought aid from the Great Spirit. Enter it then, and remember you walk upon ground hallowed by the veneration of our native people."

A great S-shaped serpent sprawls over the flat rocks. Some stones have been moved, but the design laid out by the ancient artist is still clear.

At the edge of the forest is one of many turtles found among the Whiteshell Mosaics.



EDITOR'S NOTE-BOOK

C. B. Gill (*Manitoba's Northland Rediscovered*), a native of Manitoba, obtained his degrees in Arts and in Forestry from the University of Toronto. After having served in the Middle East during the First World War, he was employed by the Dominion Forest Service from 1920 to 1930. Mr. Gill was then with the Manitoba Forest Service from 1930 until his retirement in 1961. He was Chief of Forest Management for a number of years prior to his retirement.

* * *

Sylvia Seeley (*The Thompson Project*) was educated at the University of London in England, and has since had an interesting and varied career as archaeologist, teacher, and author. She has published numerous articles as a free-lance writer, and is now on the staff of The Royal Canadian Geographical Society.

* * *

H. R. Hopper (*Kelsey: Power for Northern Manitoba*) was born in Moncton, New Brunswick, and received his early education in Moncton and Saint John. After serving with the R.C.A.F. for five years, he attended the Universities of New Brunswick and Manitoba, obtaining his B.Sc. in Civil Engineering from the latter in 1950. He has since been employed with the Highways Branch of the Manitoba Department of Public Works, and with the Manitoba Water Resources Division on the Red River Basin Investigation; at the present time, Mr. Hopper is Project Engineer for the Engineering Division of Manitoba Hydro.

* * *

Adelaide Leitch (*Rock Serpents of the Whiteshell*) is a free-lance writer and photographer who has been a contributor to the Journal for many years.

AMONGST THE NEW BOOKS

Physical Geography of Asiatic Russia

by S. P. Suslov
Translated by Noah D. Gershevsky
Edited by Joseph E. Williams

(W. H. Freeman and Company, San Francisco and London, 594 pp. $15.00)

The lifetime work of one of Russia's outstanding geographers, the late Dr. S. P. Suslov, is now available in an English edition. This book, *Physical Geography of Asiatic Russia*, translated by Noah D. Gershevsky, is a scholarly presentation of the physical geography of Siberia, the Far East, and Central Asia, and since 1947, has served as a text for advanced Soviet geography students. Undoubtedly the study is a classic in its field.

The book is divided into four major geographic regions: Western Siberia, Eastern Siberia, Far East, and Central Asia. Each of these four regions has at least three subregions, in which the recent geology, climate, hydrography, soils, natural vegetation, and fauna are examined in considerable detail. In a further area breakdown, reminiscent of Berg's great work *The Natural Regions of the USSR*, Suslov describes and analyzes the natural elements of "landscape zones", the boundaries of which are determined primarily by natural vegetation. For instance, the Western Siberian Lowlands, a subregion of the Western Siberian region, has four landscape zones: tundra, taiga, wooded-steppe, and steppe.

In essence, Suslov's hierarchy of regions, subregions, and landscapes demonstrates the integrated nature of the unity of geographic regions, whereas his subject matter, which deals with the forces affecting the landscape, is organized to reflect the interacting influence these forces have upon the landscape.

The main criticism of the English edition lies in disappointing cartography, the appearance of several errors, and the absence of eight maps from Suslov's original work. While most of the maps in the English edition were reasonably well prepared cartographically, there are far too many examples of amateurish cartography for such a high priced book. In particular, Map 4-1 has isotherm lines which are thick and uneven, and are accompanied by an ink blot; Map 4-VII displays low-grade quality of hand printing, and the outline of the continent of Asia in Map 8-VII is extremely faint. Indeed, Map 4-V a map of permafrost distribution even contains a serious error. Glaciers are mentioned in the legend but, instead of the glacier symbol appearing on the map in its proper place, another sym-

bol from the same legend (Islands of permafrost separated from general mass) is located where the Siberian glaciers actually exist.

Another error is found in a table on page 12 of the English text. Here the mean temperature in degrees Fahrenheit of the coldest month for Igarka should be $-19°$ rather than $19°$ and for Novy Port $-13°$ rather than $13°$.

The eight maps, particularly the maps of soils and natural vegetation, contained in a folder in the back of the original text are often essential aids to guide the serious reader. Unfortunately, these maps are excluded from the new edition.

At this time, however, two significant improvements over the original text are found in the English edition. One is the greater clarity of the photographs, and the other is the addition of two indexes for plants and animals.

The "free" translation by Gershevsky is, on the whole, a smooth flowing and accurate one and he should be congratulated. However, the use of one word, which occurs throughout the translation,—physicogeographic—is unsatisfactory as well as puzzling. While the Russian term fiziko- geograficheskiy has a variety of meanings depending on the context of the sentence, a number of English words can be found to fit better its meaning than physicogeographic. For example, page 5 of the Russian text contains . . . ". . . fiziko-geograficheskogo oblast' ", which is translated as ". . . a single physicogeographic territory". Perhaps a more precise translation is "a single natural region". Another example is found on page 9 of the English text (from page 13 of the Russian book): ". . . razlighnye fiziko-geograficheskii protsessy" could be translated as ". . . different physical processes took place" rather than "different physicogeographic processes took place".

Finally, this valuable text is a necessary reference book for all English-reading students of Soviet geography as well as an excellent text book for advanced students studying the physical geography of Asiatic Russia. At the same time, the availability of this book contains a challenge to the nation's leading geographers to produce a book of the same vast scope and scholarly quality.

R. M. Bone

Mr. Bone is in the foreign section of the Geographical Branch, Department of Mines and Technical Surveys, Ottawa.

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Eskimo Sculpture
by Jorgen Meldgaard
(Ryerson Press, Toronto. 48 pp. $3.00)

It has been said that the art of

(*Continued on page VII*)

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preparing a truly good, small book hinges on what is left out. This is such a book; Meldgaard has selected carefully to provide a directly effective content readily communicated to the reader and viewer. What is left in is seven drawings and seventy-five photographs, most of them by the author. The plates present some 130 carvings, singly and, sometimes, in groups. Brief notes provide the necessary data on subject, size, source, material, etc. The whole Eskimo area from Bering Strait to East Greenland is represented, and in time the specimens range from modern through historic to early prehistoric of at least 2000 years ago. There is even a grinning Alaskan "Billikins", the god of things as they ought to be, which will recall childhood to many readers.

Melgaard, an accomplished Danish archaeologist (See *Canadian Geographical Journal*, February 1960, page 64) introduces the excellent photographs with thirty-two pages of text that briefly and precisely comment on the Eskimo's culture and his prehistoric, and modern carvings. The author's first purpose, "to give an impression of what these objects meant to the Eskimo", is well met; the reader is able to share with the author his deep and perceptive affection for these carvings. They represent a rich and varied art, sentient and strong. For those who are only familiar with its modern Canadian Eastern Arctic variant, it will also be a pleasantly surprising art.

WILLIAM E. TAYLOR JR.

Mr. Taylor is in the Archaeology Section of the National Museum of Canada at Ottawa.

* * *

Flying the Chase Flag
by W. A. Hagelund
(The Ryerson Press, Toronto. 194 pp. $4.00)

When young Bill Hagelund took his minor place in the events he so vividly describes in this book, writing about them was undoubtedly a very long way from his mind. We should be grateful, then, that in his maturity and with the advantage of the experience that has come to him in the past twenty years, he has written about them in this memorable book.

Here we have a book for men of all ages. It can, however, be read with equal delight by their women folk, if only to gain some insight into the strange and insatiable urge that takes young lads away from comfortable homes and the guidance of their understanding parents.

Flying the Chase Flag brings back a good deal of the rosy lustre of youth to the over-forties, but it also jolts us back into the memory of those much less prosperous times in which we lived before the War. Nowadays, with our teenagers clamouring for their own automobiles and for other luxurious fruits of their parents' lives of labour, those pre-War years seem like something we experienced in a dimly remembered dream.

After a short spell of tow-boating in the early days of the War, the young Hagelund tried to get into the Navy. The picture of unyielding rigidity and efficiency he portrays of his encounter with the recruiting station at Esquimalt is all the more vivid because of the individualism and easy-going tolerance he met with immediately afterwards, in his successful efforts to join the crew of a whaler.

This author has a most facile pen and in his descriptions of shipboard conditions in heavy weather he really comes into his own. It needs little imagination to visualise the sound and movement of a small ship labouring under the stress of weather when they are described by phrases such as "a haunting, beseeching shriek of wind through the rigging, as if taut strings of a violin were vibrated by an invisible bow".

Sailors, whether professional or amateur, will live again through some of their own most violent moments at sea when reading this book. The true landsman who reads it will certainly wonder what manner of men are these who tolerate such conditions of wind and sea and physical discomfort.

Most men who write about the sea long after they have forsaken it for a more prosaic means of livelihood almost invariably recall the more pleasurable of their experiences. All too often they look across the years between through the rosy tinted glasses of middle age which obliterate the misery and discomfort and see only the bright and lusty star of the youth that once was theirs. Bill Hagelund is certainly not to be found in the ranks of these writers. He writes with a pen of unusual candour and does not lose sight of the fury of the elements as a result of experiencing the complacent relief when bright sunlight once again shines across the surface of an untroubled sea.

This is a Canadian adventure book of a high order and when the reader has come to its last page he will surely close the covers with regret, just as this reviewer did.

F. J. BULLOCK

Captain Bullock works in the Nautical Safety division, in the Marine Services of the Department at Ottawa.

* * *

The Living Land
by Roderick Haig-Brown
(The Macmillan Company, Toronto, 260 pp. $7.50)

This elegant and somewhat glossy book is a compendium of the natural resources of British Columbia based largely on the transactions of the British Columbia Resources Conference. It is printed on British Columbia paper with many delightful illustrations for which the designer, Mr. R. R. Reid deserves a great deal of credit.

The author, in his discussion of the natural resources, reiterates the need for conservation and the proper use of resources, the lack of knowledge and the necessity for scientific research. For this he is to be highly commended. The excellence of the presentation is, however, in this reviewer's opinion, greatly marred by indifferent writing and poor editing. This has resulted in numerous factual errors, such as incorrect area of the province, the statement that climate is a renewable resource which can be destroyed, and the inclusion of the Peace River District and Point Barrow within the Cordillera, to name a few.

Although the author sets out to provide a "geography" of the province he fails to do this adequately

(*Continued on page IX*)

(*Continued from page VII*)

because he presents tedious descriptions of the distributions of physical features, soil, water and climate, forests and agriculture that could well have been presented with far greater clarity by the use of simple maps. As not every reader can be expected to have available the excellent *British Columbia Atlas of Resources* for easy reference, the lack of maps is a most serious shortcoming. Actually the first map of the province does not appear until page 122 and this is preceded by an incorrectly titled map of agricultural areas of the Lower Fraser Valley which is made incomprehensible by the lack of a legend.

The bibliography will prove disappointing to the thoughtful reader. One would expect that a book of this nature would contain an exhaustive list of source material on the diverse resources of British Columbia. Not only is the bibliography excessively abbreviated but some of the items mentioned have been superseded by more recent, reliable publications.

The outstanding features that perhaps redeem this book are the wealth of information presented and the repeated reference to proper resource use and the need for more scientific knowledge. I. H. B. CORNWALL

Mr. Cornwall is in the Geographical Branch of the Department of Mines and Technical Surveys at Ottawa.

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Recently Received from Publishers

The Falkland Islands. By M. B. R. Cawkell, D. H. Maling, and E. M. Cawkell. (Macmillans of Canada, Limited). This is an up-to-date account of the Falkland Islands by the wife of the Superintendent of Education, supplemented by the scientific researches of Dr. Dersk Maling, and also by the ornithological researches of the author's husband who is an authority on the very rich wild life of the Islands.

* * *

Crossroads. By George B. Cressey. (Lippincott Company, Chicago). The crossroads of this book are the conflicting interests of southwest Asia. It is a dry region and the need for harvesting the water supply has always been the prime consideration of its varied inhabitants long before the wealth of the oil supply was understood.

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Cruising the Georgian Bay. By Kenneth McNeill Wells. (British Book Service, Toronto). This book should form part of the equipment of everyone who wishes to sail in the Upper Great Lakes. It gives every necessary detail about the shores of this rocky bay with its numerous islands.